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Illinois Department of Energy and Natural Resources

STATE GEOLOGICAL SURVEY DIVISION

ANNUAL REPORT
to the
BOARD OF NATURAL RESOURCES AND CONSERVATION

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1987 HIGHLIGHTS AND SUMMARY

MINERAL RESOURCES

• The estimated value of Illinois' mineral production is about $2.58 billion dollars for 1987, down by 3 percent from 1986.

• Two new proposals to improve knowledge of the state's nonrenewable energy resources have been made to federal agencies. First is a proposal to the USGS for a pilot study in Illinois to develop and test methodology to determine the availability of coal resources under existing technological, environmental, and economic constraints. The second is a proposal to U.S. DOE for matching funds to characterize Illinois' oil reservoirs and help determine the potential for improved recovery of by-passed, mobile oil.

Coal

• A new series of maps showing all mined-out areas in 73 counties has been prepared.

• Coal databases have been further expanded for stratigraphic information, petrographic data, chemical analyses, and bibliographic references.

• In the Hornsby District, 12 billion tons of Herrin Coal have been identified; about 1 billion tons may contain less than 2.5 percent sulfur.

• The Center for Research on Sulfur in Coal awarded the ISGS six new contracts amounting to just over $735,000 for research on coal desulfurization. The Coal Industry Committee funded another for about $80,000. In addition, two separate support projects for the CRSC, amounting to just over $45,000, were awarded to the ISGS. The total of $860,000 is evidence of solid endorsement of the ISGS desulfurization program.

• Scale-up of the promising fine-coal cleaning process--aggregate flotation (AF)--was proposed and a pilot study at EPRI's Homer City facility was undertaken to test the method.

• Research on microbial suppression of pyrite showed that suppressants extracted from supernatant liquids associated with bacterial activity, not the bacterial cells themselves, are responsible for suppressing pyrite.

• Experiments on leaching of chlorine from coal using ammonium hydroxide solutions, ammonium acetate, and sodium hydroxide indicated that the chlorine is removed primarily through ion exchange processes that replace chloride with hydroxide or acetate ion complexes. Ammonium hydroxide solutions were found to be the most effective in chlorine removal.

• The carbon monoxide/ethanol process, proven at the bench scale, is to be scaled up using a continuous flow unit (CFU); $1 million dollars was appropriated last year for this effort. Preliminary design work was completed for the CFU. At the bench scale, fuel-grade ethanol was also found to be effective--offering the potential for reducing costs of ethanol in the process.

• An application for a patent on a one-step ethanol desulfurization process has been filed.

• Alcohol-water mixtures used to hydrate lime by an ISGS technique resulted in hydrates with surface areas four to six times greater than those processed commercially. Such high surface areas should improve the efficiency of limes used as SO_2 sorbents in flue-gas desulfurization technologies.

• Experiments on the production of premium liquids through mild gasification of coal have shown that lower treatment temperatures and shorter treatment times improve the quality of the oil liquids derived from coal but decrease the yield.

• Explosively shattered (ES) chars were found to burn at temperatures similar to or lower than some untreated Illinois bituminous coals. Further experimentation and work is needed to determine the practicality of using ES-produced chars.

• The sale of computer-generated customized coal resource maps was initiated.

Oil and Gas

• Combining X-ray diffraction and scanning electron microscope analyses, ISGS scientists noted abundant clay minerals in the pores of petroleum reservoir rocks which, if treated with HCl (a common stimulation practice), may produce a pore-clogging gel. An operator, using this information, subsequently modified his completion practice and doubled the production rate over that of a nearby well. Other analyses of subsurface cores have also shown that authigenic clays and varying types of cements need to be considered in developing well completion and stimulation procedures.

• Illinois was selected by the U.S. Department of Energy as one of six states to negotiate a research agreement covering improved methods of oil and gas recovery and the U.S. DOE notified Governor Thompson of its intent to provide $250,000 in matching funds for this program.

• A new exploration model for exploring Silurian reservoirs in Illinois was based on the control of paleovalleys on carbonate sediments deposited on the Maquoketa unconformity surface.

• New exploration strategies for oil-bearing reefs have been described in a report on the distribution of Silurian pinnacle reefs in Illinois.

• An exploration model was developed to help industry explore and locate paleogeomorphic traps associated with the extensive paleovalley system incised into Mississippian rocks at the Pennsylvanian-Mississippian boundary in Illinois.

• Rock-eval analysis showed that the Maquoketa shale in western Illinois is not sufficiently mature to have produced the hydrocarbons found there; consequently, the oil appears to have migrated from deeper in the basin.

• The potential of the New Albany Shale Group to generate hydrocarbons has been determined in a new study involving rock-eval analyses of 252 shale samples from throughout the Illinois Basin. Samples with higher generative potential are generally located in structurally low areas at depths from 2,500 to 5,300 feet.

Industrial Minerals and Metals

• A major cooperative effort with the USGS is underway to evaluate the mineral potential of geologic formations covered by the Paducah Sheet in southern Illinois. The study also involves the states of Indiana, Kentucky, and Missouri.

• Subsurface geochemical studies are continuing for anomalous metallic values in insoluble residues as a means of assessing areas for possible mineralization.

• The ISGS hosted the 23rd Forum on the Geology of Industrial Minerals held in Aurora, Illinois, on May 11-15, 1987.

• The ISGS provided assistance in locating suitable stones to be cut and prepared for the Constitutional monument in Philadelphia and for the Battle of Normandy Museum in France.

Mineral Economics

• A major report was issued noting that the weak market position of Illinois Basin coal is partially due to lack of cost competitiveness as well as to its high sulfur content.

• In a study on the demand and supply of construction aggregates in the Chicago area, economic models indicated that population, employment, gross state product, and mortgage interest rates were the most significant factors affecting aggregate production.

• Environmentally and economically sound options were established for disposing of the material that would be excavated during the construction of the Superconducting Super Collider, should this facility be built at the proposed site near Batavia, Illinois.

ENVIRONMENTAL GEOLOGY AND GEOCHEMISTRY

• Strong efforts were made on behalf of the state and its citizens to help Illinois become the host state for the Superconducting Super Collider (SSC), to implement measures to protect Illinois' groundwater supplies, to locate additional groundwater resources, and to protect the environmental integrity of Lake Michigan and its shoreline.

Environmental Studies and Assessments

• SSC investigations continued to provide information for determining whether the proposed site is suitable, sound, safe, secure, and stable. The tunneling horizon is laterally continuous in a stable environment. There are superior options for disposing of the excavated materials, the bedrock is well suited to tunneling, and the tunnel would be in a suitable dry environment.

• Considerable assistance continued to be provided to the state in developing its SSC proposal, providing information to U.S. DOE for an environmental impact statement, and participating in coordinating U.S. DOE site visits.

• A field investigation of the proposed site for the Argonne synchroton was completed. Geological and geophysical assistance was provided in collecting information from 16 boreholes into Pleistocene materials and four holes into bedrock, and from surface geophysical surveys.

Geology for Planning

• County-by-county, geology-for-planning studies were generally put on hold while efforts were devoted to siting issues related to the SSC.

Lake Michigan Studies

• A $300,000 pass-through arrangement was developed with the federal government to fund work on lake levels in Lake Michigan and their impact on shoreline protection structures. A sidescan sonar survey, undertaken jointly with the USGS, helped to identify the major processes producing damage. These included wave surge and ice damage, not underscouring as previously believed. The knowledge of processes should aid in the design of shoreline protection structures.

• Computerized shoreline maps have been prepared illustrating the position of Lake Michigan shorelines from previous years, onshore cultural features, nearshore bathymetry, landfills, detailed park and harbor features, and marinas. These features can be overlaid on maps in various combinations and printed at different scales.

Hydrogeological Investigations

• New maps of shallow groundwater aquifers and an active groundwater resource investigation program have located new water supplies for the municipalities of Aurora, Geneva, Batavia, Montgomery, and Danville, Illinois.

• Sampling for pesticides in groundwater in western Illinois showed that pesticide concentrations vary throughout the year depending on rainfall and rates and timing of applications. Detectable pesticides exceeded accepted levels for safe consumption in two cases.

Waste Management

• Survey scientists used numerical solute transport models to rank the potential for groundwater contamination by land burial of municipal wastes for several common hydrogeological settings in Illinois.

• Investigations of Underground Injection Control (UIC) methods for hazardous wastes showed that (1) pressure conditions during the 30-year injection history at one site should not cause any hydraulic fractures of the formation, (2) laboratory systems can be developed to simulate subsurface pressure and temperature conditions to test the fate of liquid hazardous wastes, (3) two wastes so far tested were neutralized and rendered nonhazardous by reactions with subsurface rock samples, and (4) the Mt. Simon sandstone is an acceptable target for UIC in some parts of the state.

• The GIS system was used extensively to provide assistance to the Illinois Department of Nuclear Safety and the Batelle-Hanson Engineers consulting team working to find a suitable site for the disposal of low-level radioactive wastes in Illinois. A quality control/quality assurance program was instituted to ensure that preliminary screening and site recommendations meet the highest possible standards for accuracy and completeness.

• For oil-field brine injection wells, a database of some 13,500 brine injection wells was checked and verified.

Earth Hazards

• The Coal Development Board awarded $402,000 to IMSRP scientists for the ongoing mine subsidence study to maximize coal extraction while preserving prime farmland productivity. Quantitative data were provided on crop damage resulting from planned mine subsidence. In addition, data were obtained on the dynamic sequence of events that accompany mine subsidence and on the strength of mine floors and mine pillars.

GENERAL AND BASIC RESEARCH

• General and Basic Research emphasizes the three-dimensional nature of the Illinois geologic environment, the dynamic evolution of this framework, and the processes responsible for it. The intent is to provide a better understanding of our surroundings so as to ensure wise decisions regarding the use and development of the state's natural resources.

• Deep seismic data are being obtained across Illinois through active participation in Cornell University's COCORP program of seismic reflection profiling.

• All known geological structures in Illinois have been described in a significant article now in review.

• A new cross-section program has been initiated to help illustrate the three-dimensional geology of Illinois.

• Potassium/argon age dating of the alteration of Ordovician vitric tuffs has documented three Paleozoic episodes of potassic diagenesis. The diagenetic episodes were attributed to regional flow of basinal brines caused by groundwater recharge on uplifted arches in Early Devonian, Late Devonian, and Permian times.

• The cooperative geologic mapping program with the USGS (COGEOMAP) continued to make significant progress in southern Illinois in the program's fourth year of activity. Final drafts of geologic maps for three quadrangles have been completed and submitted to Northern Illinois University's Cartographic Laboratory for color negatives. Geologic mapping was completed in three additional quadrangles.

• For the first time, complete coverage of the State of Illinois with 7.5-minute topographic quadrangle maps was realized.

• The geology and hydrogeology of the Mahomet Bedrock Valley are the focus of a major report submitted to the Geological Society of America for publication as a Special Paper.

• Conodont-based correlations show that the recent discoveries of gas in the Michigan Basin are in units, in part, coeval with the Everton Dolomite or the St. Peter Sandstone. Conodont faunas are being actively studied in other Paleozoic units in Illinois.

• Digitization of well logs at the ISGS has been made possible by the development of computer software (WELLOG) at the Survey. Other active computer research and service programs have been designed to assist Survey researchers and support staff in their day-to-day activities and operations.

• The ISGS is becoming more active in the development of a program of technology transfer. This program ranges from developing interactive databases for coal information to providing customized maps for clients, to furnishing information affecting oil well completion and stimulation practices, to offering counsel and advice on landfill sites, to holding workshops, demonstrations, classes, and seminars on a wide variety of subjects for scientists, industry, government agencies, and the general public.

• Vital to the efforts of ISGS scientists, industry, state agencies and the general public are the Survey's support services in analytical chemistry, isotopic analysis, radiocarbon dating, coal analysis, and X-ray diffraction analysis. During the past year, for example, analytical chemical services made 13,000 determinations on more than 1,700 samples from 34 counties in Illinois.

• Several state databases were enhanced through the acquisition and processing of additional data. Among these are the Stack-Unit Map of Illinois, which is now automated; a computer file and maps generated for 13,000 oil and gas wells drilled in or below Devonian rocks; and an expanded, automated well database with a major addition of more than 40,000 wells from Petroleum Information, Inc.

ADMINISTRATIVE AND TECHNICAL SUPPORT SERVICES

• Heavy loads were borne by the Business and Financial Services Unit, the Human Resources Office, and the Word Processing Center as the growth of contracts and grants continued to increase.

• The volume of maps and publications handled by the mail room grew significantly in FY88, as did that handled by the ISGS duplicating services.

• In 1988, the ISGS publications operation began the transformation from traditional cut-and-paste production to streamlined computer composition, camera-ready output via laser printer, and designer software.

• Total numbers of completed publication projects increased from 136 in 1986-87 to 184 in 1987-88. Parallel increases were noted in graphics and in photography.

• The library remains in an overall no-growth position because of seriously limited space.

• Technical Design, Operations, and Maintenance Unit completed 237 repairs, fabrications, maintenance, moving, and other jobs along with 100 internal orders for electrical and electronics work.

• The Educational Extension Unit continued its program of four regularly scheduled field trips per year for students, teachers, and interested adults--an average of 120 participants per trip.

• A task force was formed to transfer a large backlog of 6,700 completed pending files to the permanent Geological Records Unit file system. The task force is on target to catch-up with this backlog of files by December 1988. Space was expanded for the Geological Records Unit files. The Unit now holds 286,412 processed drillhole records covering the entire state of Illinois.

• The Geological Samples Library contains 66,425 sets of well cuttings and 13,371 sets of core on permanent file. These samples, together with the well records and geological library, form the heart of the Illinois State Geological Survey's database.

Mineral Resources

ILLINOIS MINERAL INDUSTRY IN 1986 AND 1987

The 1986 fuel and non-fuel mineral production in Illinois was valued at about $2.66 billion, approximately 13.5 percent lower than in 1985. The value of annual mineral resources production in Illinois is approximately 40 percent that of Illinois' annual agricultural production. The decline in value occurred mainly due to a decline in the total value of oil (fig. 1) as a result of a sharp drop in the average oil price from about $26.90 per barrel in 1985 to about $14.70 per barrel in 1986, and also because of an 11.6 percent decline in oil production.

The fossil fuels--coal, oil and gas--accounted for 86.6 percent of the total value of minerals in 1986, while stone, sand and gravel and clays accounted for 11.9 percent. As a result of lower oil prices, coal's dominance in total value increased from about 62 percent in 1985 to more than 71 percent in 1986.

Preliminary 1987 data (table 1) indicate a slowdown in the state's mineral-producing industries as coal production fell by almost 5 percent and natural gas by more than 27 percent. Although oil prices improved by about 18.7 percent in 1987 over their 1986 average levels, production fell further by 11.6 percent in 1987 after a similar drop in 1986. Construction aggregates production (stone and sand and gravel) in 1987 remained nearly at their 1986 levels, despite continued vigorous growth in construction activity. A comparison of the 1985 through 1987 data on construction and aggregates production indicates that construction activity in Illinois has been growing faster than the growth in production of construction aggregates. Since growth in construction activity has maintained its momentum after the 1982 recession, it appears unlikely that aggregates supplies have been augmented by drawing down stockpiles. Rather, aggregates may have been imported into Illinois from adjoining states, especially into the Chicago area.

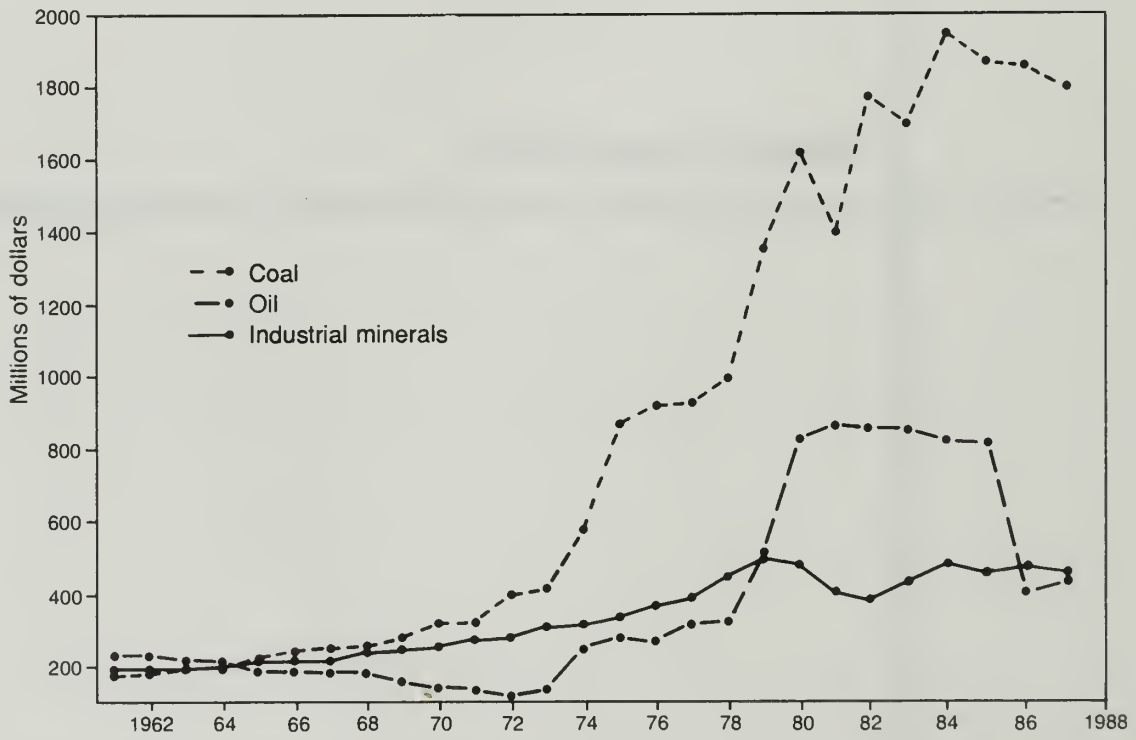


Figure 1 Value of Illinois minerals and fuels.

Table 1: Mineral production data for 1986 compared to preliminary data for 1987[a]

Minerals extracted	Unit	1986 Quantity	1986 Value (1000 $)	1987 Quantity	1987 Value (1000 $)	Percentage of change from 1986 to 1987 Quantity	Percentage of change from 1986 to 1987 Value
Fuels							
Coal	thousand tons	63,233	1,896,367	60,121	1,803,630[b]	– 4.9	– 4.9
Crude oil	thousand bbl	27,245	400,498	24,098[b]	420,510[b]	– 11.6	+ 5.0
Natural gas	thousand Mcf	1,887	4,851	1,371[b]	3,071[b]	– 27.3	– 36.7
Industrial and construction materials							
Stone	thousand tons	44,202	179,707	43,602	177,906	– 1.4	– 1.0
Sand and gravel	thousand tons	31,904	134,656	32,500	132,600	+ 1.9	– 1.5
Clay[c]	thousand tons	283	1,092	297	1,146	– 4.9	– 4.9
Fluorspar	thousand tons	W	W	W	W	+ 4.5	+ 4.5
Tripoli	thousand tons	W	W	W	W	+ 4.0	– 5.3
Metals							
Lead	tons	W	W	W	W	– 68.9	– 49.6
Zinc	tons	W	W	W	W	– 8.6	– 0.1
Silver	troy ounce	W	W	—	—	—	—
Copper	tons	W	W	—	—	—	—
Other							
Peat	thousand tons	W	W	W	W	– 1.8	– 0.5
Gem stones		NA	15	—	15	—	—
Barite, primary	thousand tons	W	W	W	W	—	—
Values that cannot be disclosed (W)		—	39,374	—	38,838		– 1.3
Total value			$2,656,560		$2,577,716		– 3.0

[a]Source: U.S. Bureau of Mines and Illinois Department of Mines and Minerals
[b]Estimated by Illinois State Geological Survey
[c]Excludes fuller's earth; included with value of items indicated by symbol W.
W = Withheld to avoid disclosing individual company confidential data.

Other Noteworthy Mineral Resource Developments

• The relatively high sulfur content of much of the coal mined in Illinois imposes a major uncertainty on the future marketability of Illinois coal. Analyses of the potential impact of pending acid rain legislation predict more or less severe negative impacts on the marketability of Illinois coal, depending on which scenario, model, and legislation are used. Utilities continue to shorten the length of contract periods and take advantage of the soft spot market. In inflation-adjusted dollars, coal now sells at prices approximately 25 percent below those of 10 years ago.

• Under these conditions, it is not surprising to see coal companies reduce their work forces. Peabody Coal Company closed its Will Scarlet Mine and reduced work force at its Eagle #2 Mine; both mines are in southeastern Illinois. Consolidation Coal Company, after acquisition of Inland Steel Coal Company, laid off an unknown, but not insignificant, number of miners and office personnel. Freeman-United negotiated contract buy-outs, leading to the closure of its Orient #4 and Crown III Mines. Arch Mineral Company on the other hand plans to open two new surface mines and two underground mines to replace production at existing operations where reserves will soon be depleted.

• The Embarras No. 1 Mine, formerly Oakland or Miracle Mine, which has been under construction in northeastern Coles County in east-central Illinois, was acquired by AMCO Illinois

from Energy Resources Development, Inc. The new owner applied for additional state assistance to complete the mine's construction, which has been stalled since late 1987. This mine is expected to produce relatively low-sulfur coal some time late in 1988.

• Coal exploration away from active mines remained at historically low levels. The most active area was in east-central Illinois, in Clark and Edgar Counties, a spill-over effect of nearby mining in Indiana where relatively low-sulfur Danville (No. 7) coal is being surface mined. Otherwise, drilling is largely tied to the development of active mines.

• Longwall technology has made another advance in Illinois coal mining. Consolidation Coal Company, which successfully introduced its first longwall face at its Rend Lake mine in 1987, now plans another unit in the same Franklin County mine near Sesser. Longwall mining is a highly productive extraction technology that recovers 80 to 85 percent of the coal seam, as compared with 45 to 65 percent for room and pillar mines on a whole mine basis; it was first introduced in Illinois by Old Ben Coal Company.

• Two Illinois crushed stone plants, both in Cook County, ranked among the 20 largest in the United States in 1988: Vulcan Materials' McCook was sixth and Material Services Corporation's Thornton was eighth.

• Competition has arrived for the Illinois fluorspar producers across the state boundary in Paducah, Kentucky. Diversified Minerals Corporation has acquired reserves and processing facilities from U.S. Steel. Almost 90 percent of U.S. fluorspar needs are met by imports while domestic production has been almost entirely concentrated in Illinois in the last few years. A new U.S. producer of fluorspar may mean fewer imports but could also pose tougher market competition for Illinois producers.

COAL

Two-thirds of Illinois is underlain by coal-bearing strata. Total coal resources amount to approximately 180 billion tons. Sixty-one of the state's 102 counties have identified coal resources of at least 500 million tons each, and 38 counties have more than 2 billion tons. The ISGS has the mandated responsibility to study and report on the vast coal resources of Illinois. The goal is to provide authoritative information to industry, government, and Illinois citizens and to promote wise development and responsible use of this natural resource.

The Survey identifies, quantifies, and characterizes the state's coal resources in terms of minability, cleanability, and potential uses. Major efforts are currently being directed toward characterizing the nature of deleterious elements in coal and their removability during standard and innovative coal cleaning techniques. Sulfur, chlorine, and ash content are a major focus of these efforts.

The need for new efforts to focus on the quantity of available coal resources has also been recognized. Not all of the 180 billion tons may actually be available for future development. Although the potential impact of some factors that affect the availability of coal on a statewide basis has been assessed in a preliminary fashion, additional factors need to be considered. Such considerations include the potential impact of various land uses, development of competing mineral and energy resources, coal quality, and various kinds of technological or environmental restrictions or exclusions on the amount of coal available for development. Thus, the Survey has proposed a study to evaluate the availability of Illinois coal resources in detail, starting with a series of representative sample areas throughout Illinois.

The growing importance and value of the Survey's coal databases for all these efforts and for other purposes, such as market studies, are also becoming widely recognized.

Coal Database Management

Coal Mine Information System, *C. Treworgy, Bargh, Morgan, Danner* The mine database was updated to show all mined areas as of January 1987. The database was used to produce a new series of mined-out area maps (80 maps, 73 counties). The new maps are at a scale of 1:100,000 so they can be overlain on the new planimetric county maps being produced by the U.S. Geological Survey in cooperation with the Illinois State Geological Survey. The readability of the new maps has been improved over older mine maps published by the ISGS by incorporating shade patterns to help distinguish different types of mines. Inset enlargements are used to depict complex areas. In counties where extensive mining has occurred in more than one seam, the mines in each seam are shown on separate maps.

The Coal Mine Information System was used to support a number of projects both within and outside the Coal Section. Mine outlines were used by the Computer Research and Services Section to identify areas unsuitable for hazardous waste disposal facilities and by the Earth Hazards and Engineering Geology Section to produce maps showing the location of mine subsidence insurance claims. Work was completed on a contract with Old Ben Coal Company to produce customized mined-out area maps for selected counties. This database was also significant for receiving a contract from the Illinois Mine Subsidence Insurance Fund to study the coincidence of mined-out areas with urban areas and population density.

Illinois Coal Mines Maps and Directories
available for the following counties

Adams	Edgar	Johnson	Mercer	Sangamon
Bond	Edwards	Kankakee	Monroe	Schuyler
Brown	Franklin	Knox	Montgomery	Scott
Bureau	Fulton	La Salle	Morgan	Shelby
Calhoun	Gallatin*	Lawrence	Moultrie	Stark
Cass	Greene	Livingston	Peoria	Tazewell
Champaign	Grundy	Logan	Perry	Vermilion*
Christian	Hamilton	McDonough	Pike	Wabash
Clay	Hancock	McLean	Pope	Warren
Clinton	Hardin	Macon	Putnam	Washington
Coles	Henry	Macoupin	Randolph	White
Crawford	Jackson	Madison	Richland	Will
Cumberland	Jasper	Marion	Rock Island	Williamson*
Douglas	Jefferson	Marshall	St. Clair	Woodford
	Jersey	Menard	Saline*	

*Require multiple maps based on seam mined

Coal Stratigraphic Information System, *C. Treworgy, Bargh, B. Smith, Sroka, Weibel* Our FY87 contract with the U.S. Geological Survey (USGS) to collect stratigraphic data for the National Coal Resources Data System (NCRDS) was completed in February with the delivery of a computer tape containing stratigraphic data for 3,710 wells. The data for 400 of these wells were collected under this contract; data for the other 3,310 wells had been compiled for an earlier project and were reformatted for submission to the NCRDS. All of these data were added to the Coal Section's stratigraphic database. Collection of data under our FY88 contract with the USGS is well underway; 300 to 400 points will be added to the NCRDS and our database. The data collected under these contracts are used for ISGS projects on mapping coal resources and studying the depositional history of coals and related strata.

In addition to the data collected for the USGS, more than 2,000 points have been added to the Coal Section's stratigraphic database during this period. These data were compiled by studies conducted by Survey geologists in the 1940s. The data were reformatted and added to the computer data base so they can be readily used to support the service and research work of the

section. Altogether, the stratigraphic database now contains information from over 13,000 sections, mostly drillholes.

Management of Coal Petrographic Data, *Harvey* The final report and the magnetic tape of data for the FY87 contract agreement on this project with the U.S. Geological Survey (USGS) was completed and copies distributed as required. This project had two main objectives: (1) stratigraphic analysis and computer entry of data from at least 400 drillholes that penetrated coal-bearing strata in Illinois and reformat existing data (described above under *Coal Stratigraphic Information System*), and (2) petrographic analysis and computer entry of data from at least 150 samples of coal representing the two main coal-producing seams in Illinois: the Herrin No. 6 and Springfield No. 5 Coals. Work on the FY88 contract agreement with the USGS continues, focusing on stratigraphic and petrographic objectives. Petrographic analyses have been determined and the results entered into our database for 57 samples of the Colchester Coal in western Illinois. Geological evaluation of the data and tabulations of results remain to be completed before the contract period ends December 31, 1988. These projects provide significant opportunities to improve the quality and size of the stratigraphic and petrographic data bases on coal.

Coal Sample Database (CSDB), *Harvey, Dreher, DuMontelle, Goodwin, Kohlenberger, Yeko, and Wilson* The Ad Hoc Committee on Sample Data Management (members include R. D. Harvey, G. Dreher, P. B. DuMontelle, L. B. Kohlenberger, J. Yeko, and recently, E. D. McKay) initiated a project that is being carried out by R. Wilson of the Computer Research and Services Section in cooperation with R. Harvey. Coordination with the various laboratories, which tested samples, was completed and the Sample Database (SDB) was designed. Work is underway to transfer the data files of the Minerals Engineering Section (coal analyses) to the Prime computer and append them to the CSDB.

Illinois Coal Bibliography (ICBIB), *Trask, Harvey, and K. Helm* During the contract year, we established an online database of abstracts and citations of reports published by the Center for Research on Sulfur in Coal (CRSC). The database also includes citations of papers published in the scientific literature concerning research funds by CRSC. Citations include discussions of test results on coal samples obtained from the Illinois Basin Coal Sample Program. Abstracts of quarterly and final reports and of technical conference proceedings are available online. Located on the Prime computer, the database can be searched easily by selecting items from menus that appear on the screen of the user's terminal or personal computer. This database, accessible by telephone using a computer, is a valuable source of information for researchers performing similar research or hoping to submit proposals to CRSC and for industry desiring to use technology being developed by CRSC-funded researchers.

Information System on Chemical Composition of Illinois Coal (ISCIC), *Trask, Harvey, R. Wilson, Dieter, and Cain* Three computerized information systems on Illinois coal--Information System on Chemistry of Illinois Coals (ISCIC), Illinois Basin Coal Sample Program (IBCSP), and Illinois Coal Bibliography (ICBIB)--were combined under one search procedure on a minicomputer in Champaign, Illinois. The databases reside in one directory and can be accessed remotely with a personal computer equipped with a modem and telephone software. Online options enable one to easily retrieve and download data to a remote station. Alternatively, the Survey staff will access the system, and printed tables of the data will be supplied upon request.

ISCIC provides proximate and ultimate analyses and other standardized test results on more than 2,600 fully described samples of Illinois coal that have been collected since 1910 from active mines throughout the Illinois coal field. Only a few samples are from currently active mines. Most samples are channel or composite channel types. Twenty-four different seams are represented from mines in 59 counties. Analytical data and sample descriptions can be retrieved by locations, seams, sample types, or by user defined analytical limits. Retrieved data can be sorted in a variety of ways, and the mean and typical range of analytical results calculated.

Coal Resources

Coal Exploration Records, *Morgan and Bargh* The precipitous decline in exploration and development drilling for coal which began in the early 1980s continued during 1987. Ten companies filed 689 plugging affidavits with the Illinois Department of Mines and Minerals, compared to about 1,400 in 1986, 1,900 in 1985, 1,500 in 1984, and 3,800 in 1983. Wells far enough away from active mines to be considered exploration wells totaled about 100, which compares favorably to the previous year's 58. Most drilling occurs near active surface mines. Perry, Randolph, St. Clair, Saline, and Gallatin Counties of southern Illinois account for the majority of these drillholes (463 holes). A significant amount of drilling (151 holes) was apparently related to the recent acquisition by Consolidation Coal Company of two large Inland Steel underground coal mines.
During the first half of 1988 of the Survey received 175 plugging affidavits. About 30 of these may be exploration holes; the remainder are related to mine development.

Coal Resources of West-Central Illinois, *Nelson, Bauer, DeMaris* ISGS Circular 540, Low-Sulfur Herrin (No. 6) Coal in the Hornsby Area, Christian, Macoupin, Montgomery and Sangamon Counties, Illinois, by W. J. Nelson with contributions by R. A. Bauer and P. J. DeMaris was released in March 1988. The report discusses coal resources, geology and mining conditions in a four-county region that contains an estimated resource of more than 12 billion tons of coal; more than 1 billion tons is believed to be relatively low in sulfur content (less than 2.5 percent). Roof conditions in underground mines in the low-sulfur coal may be less favorable than elsewhere in Illinois, but similar roof rocks have been success- fully supported using present technology.

Coal Resources of the DeKoven and Davis Coals In Southeastern Illinois. Part 1: Saline and Gallatin Counties, *Jacobson* The resources of these two coals, which generally lie close together, have never been studied systematically. The resource potential for southeastern Illinois is significant. Nearly 1,000 drillhole records have so far been interpreted and entered into a computerized database (all of Saline County and one-third of Gallatin County).

Coal: World Resources, *Damberger* A 3,000-word article was written for publication in Pergamon Press' Concise Encyclopedia of Mineral Resources. It discusses coal resource and reserve classification issues and limitations of published coal reserve data.

Coal Characterization

Coalification in North American Coal Fields, *Damberger* This is a contribution to the Geological Society of America's Decade of North American Geology volume P-2, *Economic Geology.* It summarizes the current knowledge of coalification in the coal fields of North American from a geologist's point of view. A draft manuscript was submitted in fall 1987 and is being revised on the basis of reviewers' comments.

Methods for Measuring Coal Seam Thicknesses from Old Electrical Logs, *Berggren* Geophysical logs of many kinds have been used for more than 40 years to identify and map Illinois coal resources. Most of the logs available for these studies are electric logs (e-logs) of oil and gas well surveys. About 61,000 (74 percent) of the geophysical logs in the Survey's current Basic Well Data File are electric logs. Although e-logs are valuable sources of coal information, particularly in areas where minable coals lie below the ordinary depths of mining and exploration, they are not as suitable as other types for differentiating between coal and other resistive beds, detecting thin seams, and closely measuring seam thicknesses. A report has been completed reviewing these findings along with a review of logging literature and Illinois coal resource studies. Typical e-logs are shown along with recommended methods to measure coal seams more accurately and judge coal bed thicknesses more reliably and objectively.

Mineral Matter In the Herrin Coal, *Harvey, Demir, and Lowry* A paper on this subject matter was presented at a meeting sponsored by the Engineering Foundation Conference. The paper identifies a correlation trend of decreasing mineral matter content with increasing thickness of the

seam. This and other correlations observed will assist in predicting the total mineral matter and certain trends of coal quality in unexplored areas of the Herrin Coal in Illinois. A manuscript paper is undergoing peer review for publication in the conference proceedings.

Clay Mineralogy of Coal-Related Strata, *Hughes, Moore, and Warren* Knowledge of the origin of clay minerals in coals, underclays, shales, claystones, sandstones, and limestones of the Pennsylvanian System of the Illinois Basin is essential for developing an understanding of the origin, distribution, and properties of coal. This knowledge can also be applied to the exploitation of industrial mineral resources and petroleum associated with these strata. Recent studies of the structure of illite, the most abundant clay mineral in these strata, indicate that most of the illite in underclays, coals and overlying shales and limestones is detrital, but that a small amount of diagenetic illite may occur in the marine formations overlying the coal.

Ash Fusion Characteristics of Highly Cleaned Illinois Coals, *DeMaris* A paper dealing with changes in ash fusion characteristics due to progressive removal of ash-forming minerals during cleaning was prepared and presented to the Coal Ash Symposium in Toronto. This paper reported that ash fusion properties are little or slightly positively affected by the removal of mineral matter. This work was supported by the Center for Research on Sulfur in Coal.

Three-Dimensional Determination of Physical and Chemical Structure of Coal, *Harvey* In cooperation with Dr. R. Clarkson, Chemistry Department, University of Illinois, a proposal was submitted to the Electric Power Research Institute (EPRI) for a 2-year study. The Center for Research on Sulfur in Coal agreed to share half the cost if EPRI will fund the project, which will combine optical and electron microscopic characterizations with various types of magnetic resonance measurements (similar to "cat-scans" as applied in medicine) to determine the point composition and location of both maceral and mineral components in representative coal samples. In addition, studies of the pore structure will determine the interactions of water with pore surface within macerals as well as the dimensions, distribution, and arrangement of pores. These results will provide a scientific basis to improve the model(s) of the atomic/molecular structure of coals.

Forms of Sulfur: A Fractionation Scheme for Coal and Its Pyrolyzed Products, *Chaven, Garilovic, and Ruch* In most coal research projects, there is a pressing need to know the various forms of sulfur in coal and its pyrolyzed products. A sulfur fractionation scheme has been developed for determining more forms of sulfur than are commonly reported by ASTM methods. The expanded "forms of sulfur" analysis reports elemental sulfur, solvent soluble organic sulfur, acid volatile sulfide sulfur, acid extractable sulfur (sulfate), and pyrite sulfur. Progress has been made toward developing a more reliable approach for detecting elemental sulfur in the presence of interferences. The use of low-temperature plasma ashing as a pretreatment of char in order to preserve the mineral forms (pyrite, sulfide, sulfate) for later detection is a major advance in extending forms of sulfur analysis to coal-derived solids.

Sulfur Isotope Geochemistry of Illinois Coal, *C.-L. Chou, Hackley, and Liu* The sulfur isotope technique has been applied to study the sources of sulfur and the processes of pyrite and organic sulfur formation in coal. The most prominent process is the reduction of seawater-derived sulfate by bacteria to produce isotopically lighter sulfide, which subsequently combines with iron to form pyrite and reacts with organic matter to form organic sulfur. It was observed that the higher the organic sulfur in coal, the lighter its sulfur isotopic composition, suggesting that bacterial sulfate reduction played an important role in the origin of sulfur in coal. Pyrite has highly variable sulfur isotopic compositions, and thus may have formed from bacterially reduced sulfide in highly localized microsystems. Recent results on a suite of 20 lithotype samples hand-picked from a single column of Illinois coal were presented at the 1987 Annual Meeting of the Geological Society of America in Phoenix, Arizona.

Geochemistry of Trace Elements in Illinois Basin Coals, *C.-L. Chou and Cahill* Trace elements are useful indicators of geologic conditions of coal formation. For example, high-sulfur coal (more than 3 percent total sulfur) in Illinois is enriched in molybdenum; both sulfur and

molybdenum are attributed to a seawater source. In addition, information on trace-element abundances in coal is important for effective utilization of coal. Burning coal without proper knowledge of its toxic-element contents could cause a significant environmental impact.

The existing trace-element data of Herrin and Springfield Coals were evaluated using multivariate statistical methods. Results showed that variation of many trace elements is related to mineral impurities (pyrite, clay minerals, calcite, sphalerite, and quartz) in coal. This work was presented at the 11th International Congress of Carboniferous Stratigraphy and Geology. Recently, a suite of lithotype samples were analyzed for trace elements. The geologic significance of the trace-element variation is being investigated.

Implications of an "Ordered Heteroatom" (Nitrogen, Oxygen, and Sulfur) Distribution in Coal, *Kruse* Little is known about the spatial distribution of heteroatoms (nitrogen, oxygen, and sulfur) in coal. A number of observations from unrelated experimental works lend themselves to interpretation based on an ordered arrangement of the heteroatoms. A significant part of coal's nitrogen, for example, could exist in groups of four atoms in a porphyrin ring. The strong chelating properties of such molecules may be involved in coal chemistry that is not yet fully understood. The goal is to identify applied research that, given the existence of an ordered structure, would have a reasonable probability of success.

Coal Cleaning: Physical and Microbial

Advanced Physical Fine Coal Cleaning by ISGS Aggregate Flotation, *Read, Rapp, Camp, Summers, DeMaris, Henry, Sjoken, Hurley, Ruch, Kohlenberger, and Cooper* The ISGS, in cooperation with Southern Illinois University at Carbondale (SIUC) and Northwestern University, has developed aggregate flotation (AF), a process generally capable of removing 80 to 90 percent of the ash and pyritic sulfur from fine coal and recovering more than 80 percent of the Btu value. Extensive reagent testing has demonstrated that ash and pyrite rejection and combustible recoveries obtained when using lower dosages of synthetic surfactant and alcohol blends are comparable to those obtained when using the industry standard--kerosene and MIBC. Studies of yield related to particle size of the feed showed that it was possible to attain a 90-percent yield of compliance coal (less than 1.2 pounds SO_2 per 10^6 Btu) at about 270 mesh (53 microns) for selected Herrin Illinois No. 6 Coal.

The pilot-scale, continuous-flow unit (CFU) that can process 20 to 30 pounds of coal per hour was upgraded and used for process refinement. A larger scale (0.5-ton-per-hour) test of aggregate flotation at the EPRI Homer City (PA) test facility indicated the process is technically promising. Because the advantage of the lower reagent dosage (using the ISGS and SIUC proprietary surfactant/alcohol reagent) may be offset by a higher unit cost; the development of chemicals that cost less must be investigated.

Microbial Pyrite Suppression from Illinois Coals: Microbiology and Chemistry, *Risatti, Sheridan, and Broeren* The objective of this joint effort between the Illinois State Geological Survey (ISGS) and Northwestern University is to isolate and identify microbiological by-products that can be used to enhance physical desulfurization of Illinois coals. Historically, developers of microbial methods for desulfurization of coal have focused on removal of sulfur by biological oxidation and subsequent leaching of sulfate. Recent evidence suggests that bacterial cultures wet pyrite surfaces and act as suppressants in physical separation processes. The ISGS tasks are to (1) identify the specific pyrite suppressant(s) produced by active bacteria, (2) evaluate other bacteria for pyrite suppressing activity, (3) determine optimum conditions of activity for these suppressants and define inhibitors of suppressant activity, and (4) compare the activity and chemistry of microbial suppressants to commercial suppressants.

It has been demonstrated that, using a microflotation cell assay, *E. coli* cultures actively suppressed pyrite. In addition, the suppressant could be solvent-extracted from the culture media, and cell sorption to pyrite was not responsible for suppression. It has now been determined that pyrite is also effectively suppressed by supernatant from cell preparations of *Bacillus subtilis* but

not by supernatant from cells of *Pseudomonas aenuginosa*. The suppressing activity has also been shown to be a function of culture age and pH. Both *E. coli* and *B. subtilis* are able to suppress approximately 65 percent of the mineral pyrite used in the microflotation assays. The suppressant is not associated with the lipopolysaccharide component of the cell membrane. Funding has come from the Center for Research on Sulfur in Coal (CRSC).

Distribution of Sodium and Chlorine in Illinois Coal and Their Removal by Physical Cleaning Methods, *C.-L. Chou, Demir, Cahill, and Chaven* For nearly 4 years (January 1984 to August 1987), a concentrated effort was made by the research team, under a contract with CRSC and the Illinois Coal Development Board, to investigate the distribution and forms of sodium and chlorine in Illinois coal and their removal by water leaching. The purpose of the project was to solve the Illinois coal industry's long-standing problem: that a high content of chlorine and sodium in coal may increase the rate of boiler corrosion and tendency toward fouling. The experimental results indicate that chlorine is mostly adsorbed on the organic surface as anions in micropores, and part of the total chlorine is dissolved in pore water. An important conclusion was drawn from these data: theoretically all chlorine in Illinois coal can be removed by physical cleaning methods. In practice, fine grinding and leaching by hot water are effective processes for removal of chlorine from coal. Sodium occurs as adsorbed ions on clay minerals and as dissolved ions in pore water. A final report of this project was submitted to the CRSC during the report period.

Chlorine Removal from Coal by Wet-Grinding and Leaching Processes, *C.-L. Chou, Demir, Rostam-Abadi, and Chaven* This project was initiated to develop a specific process for removing chlorine from an Illinois coal ground to 80 percent minus 200 mesh. The laboratory data to be generated are needed in support of an economic evaluation requested by the Center for Research on Sulfur in Coal. The flow stream has four stages: crushing, wet-grinding, dewatering, and leaching. Wet-grinding and leaching are the two key elements of the proposed project. The effectiveness of dissolution of chlorine from coal during wet-grinding under controlled variable water-coal ratios and chemical conditions will be tested. The leaching step is to reduce the chlorine remaining in the filter cake after the grinding and dewatering steps. This process may be readily applied to existing fine-coal preparation plants, thus enhancing the marketability of Illinois coal.

Coal Cleaning: Chemical and Thermal

Iron Sulfide Mineralogy for Coal Desulfurization, *Hughes, Warren, Adomaitis, Moore, and Glass* Desulfurization of coal with carbon monoxide and ethanol and other desulfurization methods using thermal treatments involve steps that convert pyrite/marcasite to pyrrhotite. A greater understanding of pyrrhotites, essential for process improvements, has been gained by using X-ray diffraction analysis to identify the minerals in both feed coals and process products. The goal is to measure the degree of removal of mineral matter by a specific treatment or processing step and suggest improvements in the process to take advantage of mineralogical properties. A major new development in this area was the detection of as many as seven or eight discrete pyrrhotites that form under slightly different conditions during the pyrolysis of coals.

Desulfurization of Illinois Coal Using Carbon Monoxide and Ethanol, *Shiley, Ehrlinger, Wu, Brewer, M. Chou, Bhagwat, Hughes, Moore, Amber, Hinckley [SIUC]* The carbon monoxide-ethanol (CO/EtOH) desulfurization process, designed principally as a chemical coal-cleaning method for organic sulfur removal, has been shown in laboratory tests to produce a coal-like product that meets the 90-percent sulfur reduction requirement of the Federal Revised New Source Performance Standard. The current goal is the demonstration of combined chemical treatments, a three-step technology, in a continuous-feed, gas-flow reactor (CFU) under conditions that remove both inorganic and organic forms of sulfur from high-sulfur coals. A grant for $1,000,000 (initially for 2 years and administered by the Illinois Department of Energy and Natural Resources), provides the funds for the engineering design and construction of the CFU. Concerns for adequate optimization of process conditions before completing the CFU design and long construction times have prompted a request to IDENR for a 1-year, no-cost extension.

Supplemental funds have been supplied by the Corn Marketing Board (ICMB) for CFU development and a patent application, and by the CRSC for laboratory research.

Design of the CFU is progressing with the assistance of an engineering consulting firm (C. W. Nofsinger, Kansas City, Missouri) and several outside consultants (Lyle Albright, chemical engineer, Purdue University; David Buchanan, organic chemist, Eastern Illinois University; and Conrad Hinckley, analytical chemist, Southern Illinois University). Under current CFU design goals, we seek to achieve (1) a reactor capable of processing 2 to 20 pounds of coal per hour, (2) residence times of 7.75 to 75 minutes, (3) a maximum temperature of 500°C, and (4) a maximum pressure of 500 psig. These reactor specifications should permit operations under conditions more severe than those required for adequate desulfurization.

Test results using the CFU will be used in the economic analysis of the process and the complete characterization of products and co-products. In addition, detailed process economics will consider

- process costs, which will be critically reviewed and minimized;
- value of the primary coal-like product, based upon combustion tests and meetings with potential users;
- estimated values for the co-products, taking into consideration that an oversupply of these chemical feedstocks to a free market will generally drive prices downward, and that lower prices may stimulate the development of new markets for the co-products.

In the accompanying laboratory research, samples of Herrin (Illinois No. 6) raw and preparation-plant coals and Springfield (Illinois No. 5) coals--raw, preparation-plant, and deep cleaned by advanced physical methods--are being tested to observe the effect on the process parameters of different coal types and preparations. Results to date confirm that preoxidation does not appear to significantly retard either the first step with carbon monoxide or the second step with ethanol. Experimentation on step three (magnetic separation of the spent catalyst) indicates that a reaction of the step-two product with 2-percent oxygen gas in argon for 15 minutes at 375°C promoted the conversion of a major portion of the nonmagnetic troilite to magnetic pyrrhotite. This will allow for the eventual removal of the residual sulfur by magnetic separation. Optimization of this work is underway.

Optimization of Magnetic Conversion and Separation of Sulfide Minerals in Char, *Liu, Stevenson, Hackley, and Coleman* Conversion of sulfide minerals in coal to magnetic forms during a thermal desulfurization process has been demonstrated successfully in previous studies. The major goal of this work was to optimize conditions for magnetic conversion and separation of sulfide minerals in the product char.

The three pyrolysis parameters (temperature, oxygen concentration, and treatment time) were shown to control the formation of magnetic pyrrhotite from coal pyrite. The results indicated that if the pyrolysis temperature is held at about 550°C, the highest conversion to magnetic pyrrhotite can be achieved with a combined effect of lower oxygen concentration, ranging from 0.25 percent to 0.5 percent, and a minimum treatment time (zero soak time). The results of magnetic separation of sulfide minerals in char were quite promising. The total sulfur content in a Herrin (Illinois No. 6) coal sample was reduced from 6.17 percent (3.77 percent pyritic, 2.34 percent organic) to approximately 5 percent by pyrolysis, and further reduced to 1.81 percent by magnetic separation of pyrrhotite from the char.

Stable Sulfur Isotope Studies of Sulfur Migration during Hydrodesulfurization *Hackley (in collaboration with Southern Illinois University at Carbondale)* Two ^{34}S labeled compounds, 2-thiomethyldibenzothiophene and 4-thiomethyldibenzothiophene, were prepared by researchers at Southern Illinois University. These compounds are being used to study the migration of organic sulfur into troilite (FeS) under hydrodesulfurization conditions.

Hydrodesulfurization experiments were carried out using a quadruple mass spectrometer (QMS) to analyze the profiles of hydrogen sulfide (H_2S) gas exiting the reaction system. The reactivity of the labeled and unlabeled sulfur can be monitored by analyzing the hydrogen sulfide masses associated with the ^{34}S and ^{32}S isotopes. The profiles obtained from the QMS are quite different when comparing runs made with and without the troilite present. This indicates that some of the labeled sulfur from the organic compound has reacted with or been adsorbed by the troilite. Chemical extraction and isotopic analysis of the reacted inorganic sulfide sulfur shows that a significant portion of the ^{34}S labeled sulfur has indeed reacted with the troilite even at temperatures below 440°C. The QMS data also show that some of the labeled sulfur from the organic compounds released at lower temperatures (260°C) also reacts with the charcoal medium and is not released until much higher temperatures (450° to 750°C).

Coal Desulfurization Using Perchloroethylene (PCE), *Chaven, Ruch, and Kruse* Some Indiana and Ohio researchers report that hot tetrachloroethylene can extract substantial organic sulfur in the elemental form (S_8) from coals, including coal from the ISGS sample bank. A cooperative investigation of this claim is underway between the ISGS Coal Analysis Laboratory and Eastern Illinois University. So far, it has been found that some elemental sulfur is commonly found in oxidized coal and the amount readily extracted by PCE is equal to, if not higher than, that extracted by other solvents such as petroleum ether.

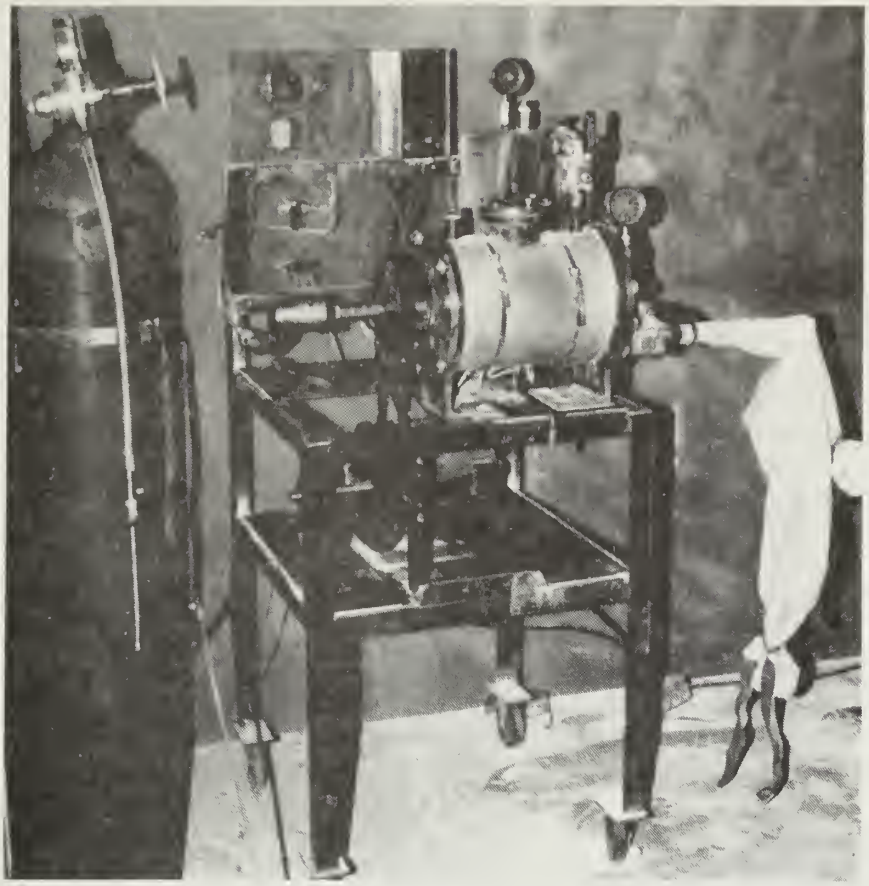
In one Illinois coal, as high as 9 percent of the total sulfur (30 percent, if calculated from "organic" sulfur) was extracted in the elemental form. A coal sample that previously had its elemental sulfur removed by PCE was further demineralized with hot dilute hydrochloric acid and hot dilute nitric acid. The residues from the acid treatment were again extracted with PCE and a substantial amount of elemental sulfur was found. At this time, it is not known whether this additional sulfur is an artifact of nitric-acid oxidation of pyrite or of the indigenous elemental sulfur released from the pores due to the acid demineralization. Further analysis is underway.

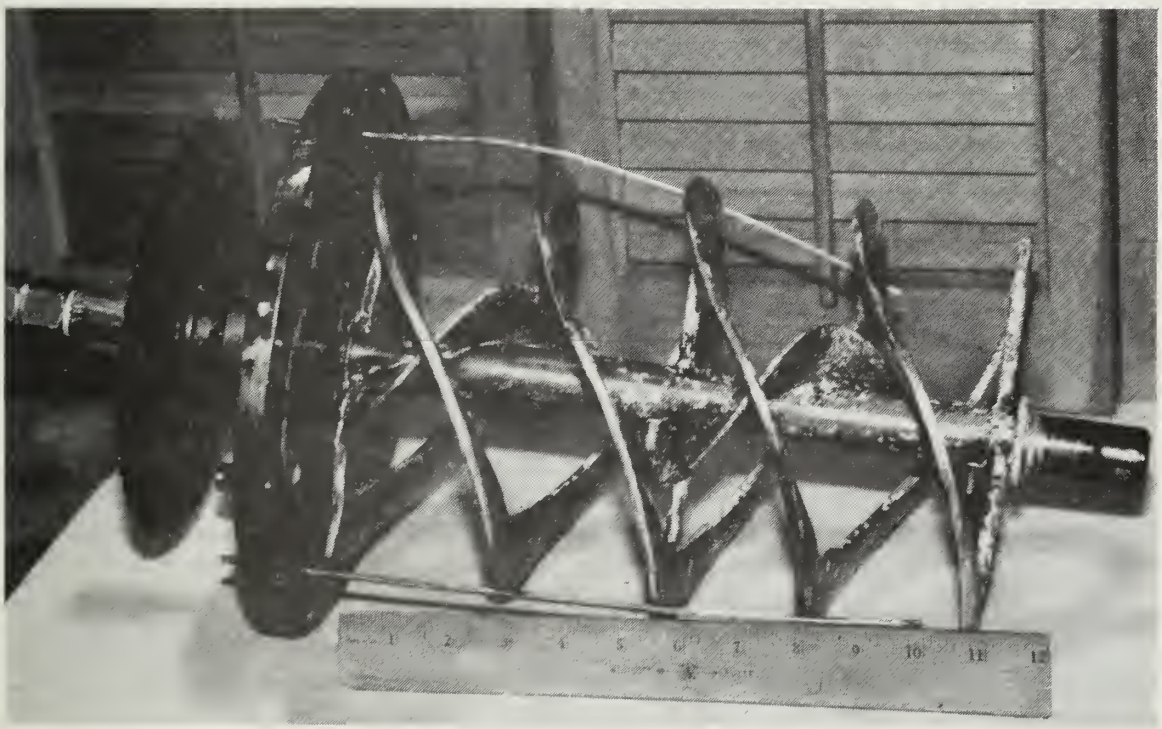
Coal Combustion

Combustion Characteristics of Coal-Derived Solid Fuels, *Rostam-Abadi, DeBarr, R. Frost, Chen, Kruse, and Cooper* A reduction in the volatile matter that accompanies most thermal and chemical coal-desulfurization processes influences combustion characteristics such as ignition temperature, flame stability, and carbon burnout in ways not yet adequately quantified. The goal of current ISGS research on partially devolatilized (PD) coal-derived fuels is to supply a broader range of combustion characterization data. Effects of reduced volatile matter and smaller particle size on the combustion behavior have been studied using five size fractions of coal and three PD fuels from the same Illinois coal.

Fuels with greater than 24-percent volatile matter content had comparable ignition temperatures, but ignition temperatures were higher for fuels with lower volatile matter. Ignition temperatures generally increased as particle size decreased, but by only 30°C for the range studied (45 to 190 microns). Thermogravimetric analysis tests indicated increasing oxidation reactivities of the fuels with increasing volatile matter content. Carbon loss data in a bench-scale combuster at the University of North Dakota under conditions representative of coal-fired boilers revealed that the fraction of carbon converted increased as residence time, temperature, and volatile matter increased, and to a lesser extent, particle size decreased. The effect of residence time on carbon loss was more pronounced for fuels with higher volatile matter content. Devolatilization did not significantly alter the slagging and fouling characteristics.

Development of High-Surface-Area Hydrated Lime for Sulfur Dioxide Control, *Rostam-Abadi, Moran, Harvey, R. Frost, Cooper, and S. Rajan (Southern Illinois University-Carbondale)* Furnace sorbent injection (FSI), the injection of a pulverized, dry, calcium-based sorbent into existing coal-fired power plants for control of sulfur dioxide emissions, is an emerging technology that has received considerable attention in recent years. Under furnace conditions, the sorbent decomposes to lime that reacts with sulfur dioxide and oxygen to form calcium sulfate. A major factor in the total cost is the effective utilization of the calcium solvent.





Bench-scale hydrator (top); double helical blade mixer.

ISGS engineers have prepared hydrated limes having surface areas from 30 to 60 m^2/g using alcohol (methanol or ethanol) water in a proprietary hydration process at atmospheric pressure. Sulfur-dioxide-removal characteristics of the high-surface-area hydrates were measured in a bench-scale circulating fluidized-bed combuster at SIUC. Sulfur dioxide reductions exceeding 95 percent were observed, and the emissions were considerably below the EPA standards of 1.2 pounds SO_2 per MMBtu. The coal used in the bench-scale test was sample IBCSP-3 from the Illinois Basin Coal Sample Program, a preparation-plant blend containing 80-percent Springfield (Illinois No. 5) and 20-percent Herrin (Illinois No. 6) coals and having approximately 2.3-percent total sulfur and 13,500 Btu per pound.

To produce larger quantities of the hydrated lime for further testing, a bench-scale pressure hydrator that can be operated at pressures up to 15 atmospheres and temperatures up to 200°C has been designed, constructed, installed, and tested. The bench-scale hydrator will produce 10 pounds of hydrated lime per batch. Surface areas of material produced at bench scale were 10 to 20 percent lower than those produced initially under comparable conditions at lab scale.

Sorbent Evaluation for Pressurized Fluidized-Bed Combusters, *Chen, Rostam-Abadi, and Harvey* Fluidized-bed combustion (FBC) offers great potential to expand the use of Illinois coal while protecting the environment. The single most attractive advantage of the FBC process over conventional pulverized-coal combustion is that sulfur is removed in situ during combustion by the addition of calcium-based sorbents.

The goal of this new study is to examine and identify the reactivities of different Illinois limestones and dolomites to adsorb sulfur dioxide under fluidized-bed combustion conditions at elevated pressures (PFBC). The objective is to gain a better understanding of the sorption mechanism from the reaction rate and saturation capacity data obtained in this work.

In this work, ten carbonate rocks from different quarries in Illinois will be investigated. Calcines will be prepared and sulfur dioxide reactivities of these calcines will be evaluated under PFBC conditions in a pressurized thermogravimetric analyzer and in a lab-scale pressurized batch fluidized-bed reactor. The influence of temperature, pressure, particle size, oxygen, carbon dioxide, and sulfur dioxide concentrations on the sulfation rate and capacity of the sorbents will be investigated. Physiochemical properties (porosity, pore size distribution, grain size, and impurities) of carbonate rocks and products will be obtained to explain sulfation reactivity. The reactivity data will be evaluated using models for fluidized-bed sulfur sorption to predict the sorbent performance under typical PFBC operating conditions.

Elemental Mass Balance Studies for the Chiyoda SO_2 Scrubber at Abbott Coal-Fired Power Plant, *Cahill, Henderson, R. Frost, and Steele* The University of Illinois, in reconverting the Abbott Power Plant to a coal-burning plant, chose the Chiyoda Scrubber as the most innovative, efficient, and reliable process available for flue-gas desulfurization. The Chiyoda system has a desulfurization efficiency of greater than 95 percent and produces a pure gypsum by-product. The ISGS is involved in characterizing the coal, limestone, flyash and by-product gypsum as part of a chemical mass balance program designed to test the scrubber system. The project is coordinated locally by Dr. Phil Hopke of the Institute for Environmental Studies with funding from EPRI through the Radian Corporation. The study will address the efficiency of the process in removing sulfur and trace elements from the stack gases produced in burning Illinois coal and minimizing their impacts on air and water quality.

Liquids and Gases from Coal

Production of Premium Liquids by Mild Gasification, *Stephenson, Williams, Rostam-Abadi, Kruse, and Cooper* The goal is to produce premium coal-derived liquids by a mild gasification approach and correlate their properties as a function of (1) temperature in the 450° to 550°C range, (2) treatment times ranging from 30 to 60 minutes, (3) different gas environments, (4) gas flow rates of 100 to 200 cc per minute at STP, and (5) two different heating modes (slow and

quasi-flash). The most promising oils produced in gram-sized quantities under various pyrolysis conditions were analyzed by the Western Research Institute (WRI). An evaluation of the fuel value of the various oils has been performed using WRI data: carbon-hydrogen-nitrogen, sulfur, specific gravity, ash, neutral fraction weight percent, simulated distillation, and aliphatic/aromatic content by combined gas chromatography-mass spectroscopy.

Lower gasification temperatures and shorter treatment times resulted in higher quality oils. The chars remaining had higher volatile matter but a commensurate reduction in oil yields. The best oils were produced in either a hydrogen or steam environment. Generally, increased flow rate resulted in small increases in oil quality and yield but had little effect on char volatile matter. Increased heating rate resulted in slightly lower oil quality with oil yield and char volatile matter slightly higher. Oil analyses indicate the greatest potential for these coal liquids is in extraction of specialty chemicals and possibly fuel blending components.

Investigation of Highly Combustible Char, *Hackley, Liu, and Coleman* Despite success at the ISGS in producing char with very low sulfur levels by hydrodesulfurization, the product would be difficult to market for use in current burners because combustion properties that usually accompany the low volatile matter are substandard. The objective of this research was to produce highly combustible char from explosively shattered (ES) coal.

Thermogravimetric combustion data for chars produced under proprietary conditions from ES coal show that combustion properties are excellent despite a low (less than 10 percent) volatile matter content. The high combustion reactivity is currently believed to be due to very high surface area. Successful scale-up of a process producing low-sulfur, highly combustible chars would have the potential for significantly expanding the market for Illinois high-sulfur coals.

Technical Support Services

Illinois Basin Coal Sample Program (IBCSP), *Kruse, Harvey, Summers, Ehrlinger, and Chaven* The Illinois Basin Coal Sample Program (IBCSP) was initiated in 1983 for the Illinois Coal Development Board and became interstate in 1986 when Indiana added a coal to the program and accepted a share of the maintenance cost. Homogenized samples of the five coals (3/8 inch x 0) collected for the program are maintained under a nitrogen atmosphere in 55-gallon barrels. Analyses for 5 years show that the sampling procedures produce representative samples and that changes in the samples are relatively minor.

One additional sample, a 3-ton channel sample that matches the only Illinois coal in the Premium Coal Sample Program (PCSP) at Argonne National Laboratory (ANL), was collected for the IBCSP by ANL and prepackaged in three sizes of containers (5 gallon, 1 gallon, and 1 pint). This sample is of higher quality than the remaining five because it was maintained in an inert atmosphere throughout collection and processing.

Three new samples will be added in late 1988: IBCSP-7, a sample having a $^{34}S/^{32}S$ isotope ratio for its organic sulfur that differs significantly from that of its pyritic sulfur; IBCSP-8, a state-of-the-art clean micronized coal sample; IBCSP-9, a sample low in organic sulfur and high in chlorine.

During the past year, 48 individuals ordered more than 170 samples totaling more than 2,600 pounds of coal. Of the 106 individuals requesting samples over the life of the program, 31 were from Illinois universities and 22 from in-state government laboratories. No requests came from Illinois industry. Out-of-state requests included 26 from universities, 14 from industry, and eight in government research. Requests from outside the United States included two from universities, one from industry, and two from governments.

Low Temperature Ashing/Petrographic Laboratory Service, *Lowry* Seventy-four samples were processed using low-temperature ashing (LTA) for various projects--43 for ISGS personnel, eight for Argonne National Laboratory (round robin), 20 for graduate students from the University

of Illinois (under Steven Altaner), and three for an experimental procedure for specimen preparation of brain tissue for SEM and X-ray analyses (Alzheimers Disease), which proved to be better than any previous preparation procedures.

SEM Laboratory, *Harvey, Lowry, Seyler* Coals, devolatilized coals, calcined limestones, hydrated limes, heavy minerals from sands and gravels, oil and gas reservoir strata, and other materials have been characterized at high magnification with our new SEM, shared cooperatively with the Illinois Natural History Survey. Two staff members (Lowry and Seyler) received special training in the operation of the energy dispersive spectrometer (EDS), an accessory to the SEM.

Coal Technology Transfer and Information Services

Information on Coal Mining and Geology, *Danner, DeMaris, and Miller* More than 100 requests for information on past coal mining and on coal resources at specific sites were answered by phone or letter. Inquiries come from state and federal agencies (including Illinois Department of Transportation, Illinois Department of Mines and Minerals, HUD), engineering consultants and local officials, as well as private individuals. Requests concerning mining under homes and farms and coal resources are the most common type from the general public. In recent years, requests related to the potential for mine subsidence have increased.

Online Coal Information Systems, *Trask, Harvey, R. Wilson, Dieter, and Cain* About 30 persons requesting information on the quality of Illinois coal were provided with data from ISCIC, the Survey's Information System on Chemistry of Illinois Coal. Two inquiries were from out-of-state companies considering the purchase of more than 1 million tons of coal per year. We also provided data for a report designed to attract foreign buyers for Illinois coal.

Short Course on Technical Review of Geologic Maps and Sections, *Damberger* A 3-day course on this subject was organized for the benefit of the COGEOMAP team, other Survey staff involved in the production of geologic maps, and outside participants. Included were two professors and two students of Eastern Illinois University, two graduate students of the University of Illinois, and two staff members of the Indiana Geological Survey. The short course was offered by Mitchell W. Reynolds of the U.S. Geological Survey.

Twenty-eighth International Geological Congress Field Trip T143, *Damberger, Baxter, Devera, Jacobson, Kolata, Nelson, Norby, Seyler, and Treworgy* In connection with the 28th International Geological Congress, to be held in Washington, D.C. in July 1989, a 10-day field trip through the eastern U.S. coal fields will be offered. The first 2 days will be spent in Illinois. The trip will examine both Mississippian and Pennsylvanian strata in the southern portion of the Illinois Basin. The stops for this field trip were selected, field checked, and described; and a dry run was held with the trip leaders. A final draft of the field guide has been prepared and submitted to Blaine Cecil, U.S. Geological Survey, who is in charge of the entire field trip.

OIL AND GAS

The most serious short- and long-term energy problem in the United States has been identified in a U.S. Department of Energy (U.S.DOE) report as the inadequate supply of domestic petroleum for transportation fuels. Of major concern are the ongoing developments in the oil industry that are affecting so significantly the nation's energy supply, economic development, and competitive edge. Impacts nationwide have been substantial.

Independent oil producers in Illinois have been made especially vulnerable. Many stripper wells have become too costly to operate and have been shut in. Low prices have been insufficient to justify risk taken in exploration. Capital necessary for the continued support of independents has been severely restricted as banks have become reluctant to finance high risk ventures under low price scenarios. Both the lack of capital and lack of research capability are strongly inhibiting the

ability of independents to find domestic reserves and maintain supplies--to continue their role as a major source of oil and gas production in the United States.

The result is a rapidly widening gap between consumption and production with demand outstripping domestic supply. The widening gap means increased imports to meet the nation's balance of payments, and a threat to security of supply and defense needs. Imports are expected to make up more than 50 percent of the nation's supply of crude oil by the early 1990s, putting the United States in a steadily worsening position with growing vulnerability.

Against this backdrop, the Illinois State Geological Survey is attempting to position itself to respond to the needs of the state and the nation and to be of maximum help to the independent oil industry of Illinois. The ISGS has expanded its program of research and service in oil and gas. Its goals are to help industry find economic means of getting more oil out of the fields already discovered; to provide additional ideas and incentives to industry; to explore for and develop Illinois' oil and gas resources; and to provide more complete and timely information to the independent oil industry that is unable to carry out the required research.

The United States' dependency on oil, its current position in the world oil market, the state of the Illinois oil industry, and the anticipated high potential of remaining unrecovered petroleum resources in existing fields all provide strong incentives for establishing an Illinois-specific integrated, comprehensive oil and gas research program. Over the past 15 years, unstable world oil markets have demonstrated the secondary nature of the United States' role as an oil producer and highlighted the need to develop a fundamental understanding of the geoscientific nature of the petroleum-producing reservoirs. The specific objective is to prolong and enhance the productivity of mature and depleting petroleum resources, such as those of Illinois. By pursuing an overall objective of improving recovery efficiency, a properly focused, well-managed and financed long-term oil and gas geosciences research program could

- define the state's remaining unswept mobile oil (currently estimated at 1.4 billion barrels);
- provide otherwise unobtainable research to the Illinois Independent Oil Producers;
- persuade stripper well operators not to abandon access to oil remaining in place;
- develop technology to enhance production from mature fields;
- help maintain an industry whose cash flow provides needed strength to the Illinois economy by providing ideas and technology to industry that will lead to extensions to existing fields and targeted infill drilling for by-passed oil.

Oil and Gas Program for Illinois

The ISGS Oil and Gas Program aids the industry in exploration and development of Illinois resources by providing comprehensive data collection, mapping, and subsurface stratigraphic research required to generate new petroleum targets and new techniques for locating and exploiting existing fields and plays. Recently, new research has been directed toward discovering how and when oil was generated in Illinois and toward improving oil recovery from Illinois' existing reservoirs.

Oil and gas data are made available to the public via (1) an annual report on the petroleum industry in Illinois, (2) a monthly drilling report, (3) oil and gas pay zone maps (showing the geographical area underlain by oil production from individual rock layers), (4) maps showing the subsurface depths of selected strata, (5) special publications, and (6) the Geological Records Unit. The state-mandated repository for well records contains more than 270,000 files.

Oil and Gas Statistics

Annual Statistics and Records, *Huff and Black* From the wells drilled each year, geological records, including well logs, are provided to the Survey by industry in accordance with state laws and regulations.

Number of holes reported in 1987, compared to 1986

	1986	*1987*
Oil and gas tests		
New holes	2,458	1,729
Old holes drilled deeper	97	0
Service wells		
New holes	10	69
Old holes drilled deeper	1	0

The 1,729 new holes drilled in 1987 resulted in 824 oil wells, 46 gas wells, and 859 dry holes. Illinois ranked seventh in the United States in total wells drilled in 1987, and fourteenth in total oil production.

In 1987 the annual production of oil reached an estimated 24,097,000 barrels, 12.8 percent less than in 1986. Discoveries reported included 1 oil field, 2 gas fields, 16 new pay zones in existing fields, and 25 extensions to fields; the new fields are small.

Illinois production in 1987, compared to 1986

	1986 MB/mo.	1987 MB/mo.	% change from 1986
January	2,664	2,000	-25
February	2,650	1,898	-28
March	2,502	2,080	-17
April	2,376	1,985	-16
May	2,267	1,981	-13
June	2,201	1,995	-9
July	2,241	2,050	-8
August	2,017	2,007	-5
September	2,158	1,983	-8
October	2,158	2,029	-6
November	1,900	2,003	+5
December	2,110	2,086	-11

The following 12 counties accounted for 65 percent of the reported new holes drilled:

County	No. of holes	% state totals
Crawford	255	14.7
Brown	107	6.2
Wayne	100	5.8
Clay	94	5.4
Jefferson	92	5.3
Lawrence	80	4.6
Richland	76	4.4
Jasper	73	4.2
Schuyler	65	3.8
White	62	3.6
Edwards	60	3.5
Adams	58	3.3
	1,122	*64.8*

Oil and Gas Resources

Resources Estimates, *Leighton, Eidel, Mast, and Oltz* The current knowledge of oil and gas resources in the Illinois Basin is being summarized in a volume for the AAPG's World Petroleum Basin Series, *Interior Cratonic Sag Basins*, which will be published in 1990. Current figures in the preliminary draft of this volume indicate that just under 10 billion barrels of oil-in-place have been discovered in Illinois. Of this amount, 3.4 billion barrels have been produced. The U.S. Department of Energy has recently indicated that, of the amount of remaining oil-in-place in Illinois, 1.5 billion barrels is unswept mobile oil and 4.4 billion barrels is immobile oil. These sizable targets are significant objectives for the Illinois State Geological Survey's oil and gas research and service program. The Survey's immediate efforts are focusing on reservoir inhomogeneities that control the unswept, by-passed oil. This appears to be the more promising economic target for research in the near term--a target that could assist the nation in helping to meet its shortfall of domestic hydrocarbon liquids for transportation as well as assist the state's producers in their economic development of this natural resource and increase Illinois' oil production (fig. 2).

In addition, some 462 million barrels of potentially recoverable oil are carried by the USGS in their latest estimates of the undiscovered hydrocarbon potential for the Illinois Basin. Efforts are underway to identify plays in Illinois and their remaining potential, to verify or modify these estimates, and especially to provide ideas, information, and incentives to industry to explore and develop Illinois' resources.

Improved Oil Recovery Methods and Concepts

Aux Vases Sandstone Reservoirs in Ziegler Field, Franklin County, Illinois, *Seyler* Preliminary porosity, permeability and SEM-EDS analyses of core, core descriptions, and log analyses from two closely spaced wells show large variations in reservoir characteristics in short lateral and vertical directions, illustrating the need for further work on reservoir heterogeneities. Large volumes of authigenic chlorite and illite clays have been identified in the cores.

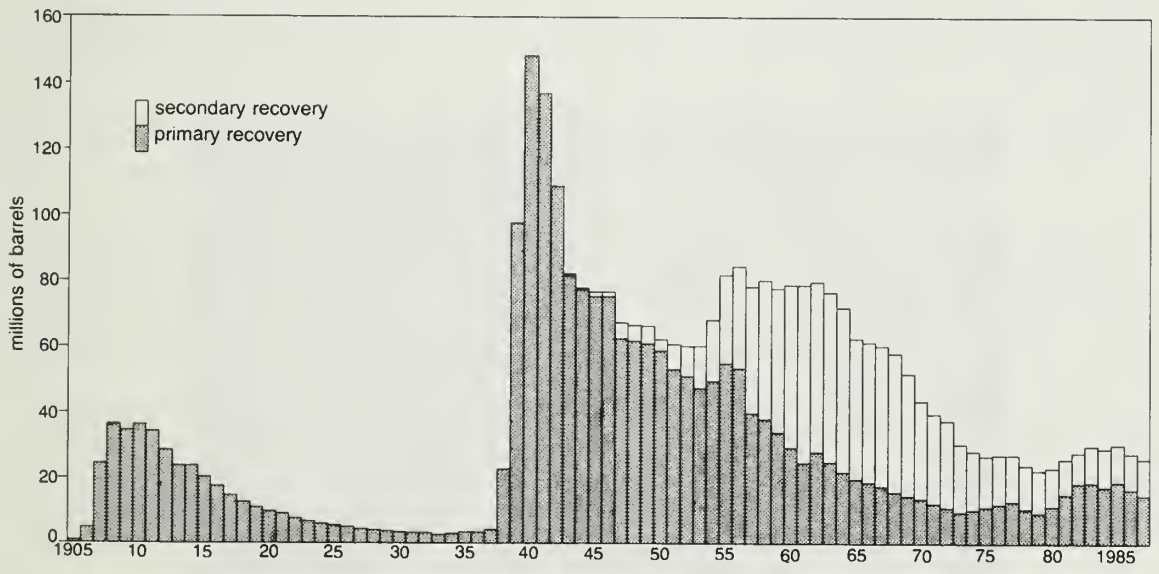


Figure 2. Annual oil production.

Deeper Pool Extension Study in Storms Consolidated 12-6S-9E, White County, Aux Vases Sandstone, *Seyler* The Storms Consolidated Field has produced primarily from the Waltersburg, a Middle Chesterian Sandstone. Preliminary work on a core from a recently developed, deeper producing horizon in the Aux Vases has shown that large vertical variations in permeability are due to differences in cementing agents and presence of authigenic clays. SEM/EDS and core flow experiments are planned to quantify the observations and aid in determining appropriate recovery treatments.

Analysis of an Aux Vases Sandstone Reservoir in 7S-3E, Franklin County, *Seyler* Reservoir characterization work has been undertaken on a productive Aux Vases sandstone penetrated in a recent wildcat discovery. Preliminary SEM-EDS analysis of the reservoir has shown the presence of authigenic clays. It is postulated that these clay minerals react with fluids commonly used in completion and recovery treatments of oil wells. As a consequence, rock-fluid reactions may need to be considered when designing drilling, completion, and recovery treatments. Core displacement experiments designed to demonstrate some of these reactions are planned.

Deposystem Model for Cypress Sandstone, *Seyler* Interpretation of electric log signatures in a closely spaced cross section grid in the oil-productive area of Illinois has revealed a pattern of facies changes within the Middle Chesterian Cypress Sandstone. These facies, representing different depositional environments, have been mapped and are being studied to determine the relationships between deposystems and oil reservoirs.

Analysis of the Cypress Reservoir in the Parkersburg Field, Edwards County, *Seyler* This study, which was originally undertaken to aid in the assessment of rapid production declines experienced in some wells, has been expanded. Early thin section, SEM/EDS, and XRD analyses showed the presence of authigenic clays and the likelihood that these contribute to recovery problems in this reservoir. Cross Sections, subsurface mapping, and deposystem analyses have been added for an integrated and comprehensive approach of reservoir characterization. It is hoped that such studies may lead to improved oil recovery for similar reservoirs in Chesterian sandstones.

New Program for Improved Oil Recovery, *Leighton, Eidel, and Oltz* A letter of intent to Governor Thompson dated June 15, 1988 has been signed by U.S. DOE's J. Allen Wampler, Assistant Secretary, Fossil Energy, to undertake a cost-shared research program for improved oil recovery from Illinois' existing reservoirs. Elements of this program call for (1) project planning



Scanning electron microscope (SEM) photo showing pore clogging clay minerals in sandstone reservoir; magnification = x1230.

and prioritization of reservoirs for study, (2) geological framework studies, (3) characterizing the heterogeneity of selected reservoir type, (4) data synthesis, (5) engineering appraisal, (6) database management, and (7) technology transfer. Final details of the agreement are currently being negotiated and will be available upon conclusion of the negotiations. Cost-sharing is to be on a 50-50 basis between the state and federal government and is in furtherance of a Memorandum of Understanding signed by Governor Thompson and J. Allen Wampler of U.S. DOE on December 2, 1986, to promote cooperative research on fossil fuels.

In addition, this past year the Illinois State Geological Survey joined the Geoscience Institute, headquartered at the University of Texas at Austin. The ISGS is one of 15 charter members whose goal is to promote national multidisciplinary, geoscience research to improve the recovery of hydrocarbons from existing discoveries. The ISGS, together with the Kansas State Geological Survey and the Oklahoma State Geological Survey, co-hosted a Midcontinent Regional Forum on June 9 and 10 to consider the needs for research for such a program. The meeting, one of six regional sessions, was attended by more than 60 people representing industry, academic institutions, and state geological surveys. Panels of experts considered the needs for databases, reservoir characterization, reservoir performance, reservoir prediction, advanced extraction technology, stimulation and completion technology, scientific drilling, and technology transfer.

New Exploration Methods and Concepts

Shallow Petroleum Occurrences in West-Central Illinois, *Crockett, Seyler, and Whitaker* A 5-year exploratory effort of nationwide interest has focused on Silurian oil accumulations 450 to 650 feet deep in the area east of Quincy, Illinois. Geological mapping has revealed that the largest oil accumulations in this part of Illinois occur in the dolomitized basal portions of relatively thick Silurian Kankakee carbonate strata that were deposited in subtle paleovalleys eroded in the underlying Ordovician Maquoketa Shale. The delineation of this paleodrainage pattern could prove to be a key in the search for additional hydrocarbons in similar traps.

Mt. Auburn Trend for Silurian Reservoirs, *Whitaker* This study is designed to explain the occurrence of numerous oil and gas reservoirs along the Mt. Auburn Trend that extends between Decatur and Springfield. The play concept of the present oil-producing area will be addressed. Using the planned report as an exploration model, ideas and incentives may be provided to oil companies to increase efforts in exploration for this type of reservoir.

Silurian Reef Distribution in Illinois, *Whitaker* A report was prepared on Silurian reefs, which have accounted for more than 92 million barrels of oil produced in Illinois thus far. The report presents a hypothesis that the reefs are more widespread than had been previously thought. Expanding the area of exploration for Silurian reefs could result in discoveries of many new reef-related oil fields. Prospective areas for reef exploration are discussed as well as exploration methods that can be used to locate reefal targets.

Hydrocarbon Entrapment in Devonian Dolomites, *Whitaker* A preliminary study has been completed on Lower Devonian oil fields in southwest Illinois. A plausible explanation has been developed for these fields showing them to be related to a regional pinchout of porous, oil-filled Lower Devonian dolomite. Several oil fields had been discovered along this trend, but no geologic reasons have been published to explain their occurrence.

Tar Springs Sandstone Distribution, *Whitaker* Plans are underway to study the origin and distribution of the Tar Springs Sandstone, a major oil reservoir in Illinois. This study will improve knowledge of the depositional history, occurrence, and heterogeneity of the Tar Springs sandstone throughout the southern part of the state. These findings will then be used to assess the potential for additional hydrocarbon reserves in the Tar Springs.

Hydrocarbon Accumulations in Paleovalleys at the Mississippian-Pennsylvanian Unconformity in the Illinois Basin, *Howard and Whitaker* A network of 300 million-year-old valleys lies buried just slightly more than 1,000 feet below the present surface of southern Illinois.

In Pennsylvanian time, when sea level rose, stream gradients were reduced such that porous sand bars along the valley floors were buried by impermeable mud, thereby creating the potential for hydrocarbon traps. Until the recent publication of Illinois Petroleum 129, *Hydrocarbon Accumulation in a Paleovalley at the Mississippian-Pennsylvanian Unconformity near Hardinville, Crawford County, Illinois: A Model Paleogeomorphic Trap*, little public information had been provided on the importance of petroleum trapped in or by the mud that filled in these valleys. In this study, the authors discuss the accidental discovery and episodic exploitation of a 1 -mile long oil-bearing sand bar, which could eventually yield 1.5 million barrels of oil. With this report as a guide, explorationists can make a deliberate attempt to find other such hydrocarbon traps in paleovalleys or updip truncation traps at their margins throughout much of the state.

Update of Basinwide Paleogeologic Map of the Sub-Pennsylvanian Chesterian Surface, *Howard and Whitaker* To aid industry in the search for hydrocarbon traps associated with the Mississippian-Pennsylvanian unconformity, an updated and revised version is being prepared of the 1971 *Paleogeologic Map of the Sub-Pennsylvanian Chesterian (Upper Mississippian) Surface in the Illinois Basin*, from ISGS Circular 458, by R. H. Howard and H. M. Bristol. Armed with up-to-date knowledge of where the paleovalleys are, explorationists can use the map to help define the multiple plays associated with them. Revisions of the 1971 map covering parts of Indiana and Kentucky, supplied by the respective surveys of those states, are being combined with Illinois' revisions in order to produce a new map next year.

Illinois and Indiana-Kentucky Geological Societies Joint Publication, Vol. 2, Geology and Petroleum Production of the Illinois Basin, *Crockett, Seyler, Howard, and Whitaker* ISGS authors contributed articles, as described briefly below, to the 272-page compilation of regional geological concepts and case histories of the development of individual oil and gas fields, published in June 1988.

- "Main Consolidated Field, Basal Pennsylvanian Fluvial Sandstone Pool" (Howard, Whitaker) describes a 1.4 million-barrel hydrocarbon accumulation in a sandstone lens deposited along the floor of a paleovalley at the Mississippian-Pennsylvanian unconformity. An exploration model for similar plays is discussed.

- "Frogtown North Field" (Whitaker) describes some of the characteristics of reservoirs associated with Silurian pinnacle reefs.

- "Buckhorn Consolidated Pool Study" (Crockett) summarizes characteristics of the Silurian Kankakee carbonate reservoir at the Buckhorn Consolidated Field in western Illinois. In addition, it briefly illustrates the exploration model of Kankakee carbonate accumulations in paleovalleys eroded into the Maquoketa Shale.

- "St. James North Pool Study" (Seyler) illustrates the Carper Sandstone and lower Mississippian turbidite production from the St. James North Pool.

- "Pennsylvanian System" (Howard, Whitaker) summarizes petroleum entrapment in Pennsylvanian strata in the Illinois Basin.

Distributed throughout the volume were ISGS maps of producing horizons (Howard).

Hydrocarbon Generation and Migration Studies

Potential Source Rock for the Ordovician Oil in the Illinois Basin--An Organic Geochemical Study, *M.-I.Chou, Dickerson* Twelve shale samples from a core taken in Montgomery County, Illinois, one sample from the St. Peter Formation, and eleven from the Joachim Formation were analyzed. The St. Peter Formation is low in total organic carbon content, low in hydrogen content, and high in oxygen content, suggesting that the St. Peter is a poor hydrocarbon source. However, a majority of the eleven Joachim samples are rich in hydrogen and poor in oxygen

indicating potential hydrocarbon source (type I kerogen). The Joachim samples are, however, relatively low in total organic carbon content and thermal maturity.

Source Rock Studies of the Ordovician Maquoketa Shale, *Crockett, Oltz, Dickerson, and Autrey* Source rock screening studies of Ordovician rocks in central western Illinois (McDonough, Schuyler, and Fulton Counties) and of upper Ordovician Maquoketa Group Shale samples in western Illinois (Adams, Brown, Schuyler, McDonough, and Hancock Counties) indicate that facies within the Maquoketa have potential as hydrocarbon source rocks. Total organic carbon and rock-eval (pyrolysis) analyses describe the Maquoketa as an "excellent" to "very good" potential source rock; however, these rocks are immature in western Illinois. Whole-rock extracts from Maquoketa samples in western Illinois suggest that oil from these rocks may be a contributor to Illinois Basin hydrocarbons. Plans have been made with investigators in industry (Dan Jarvie, Humble Instruments) and academia (Michael Kruge, Southern Illinois University) to continue source rock evaluation of the Maquoketa Group in Illinois. Source potential, maturation, activation energies required for maturation, migration, oil characterization, distribution and volume of Maquoketa hydrocarbons will be investigated in this study.

Oil-Source Potential of the New Albany Shale Group in the Illinois Basin, *M.-I.Chou, Dickerson, and Sargent* The hydrocarbon generative potential and production index of New Albany Shale Group samples (core and cuttings) throughout the Illinois Basin were obtained from Rock-Eval (T_m) pyrolysis; these are being integrated with other available geologic and geochemical data.

Rock-Eval (T_m) data for 252 shale samples (143 core and 109 cuttings) from throughout the Illinois Basin were analyzed. Seven geochemical logs, a generative-potential map, a pyrolysis temperature-maximum map, and a production-index map were generated. The results indicate that the upper portion of the New Albany, the Hannibal and Saverton Shales, have the lowest potential for oil generation. The Grassy Creek Formations, and stratigraphically lower shales of the New Albany, generally have good oil-generative potential. As noted previously, samples from the Hicks Dome area of extreme southern Illinois are over-mature but have some potential for gas generation. Source rocks which have both good oil-generative potential (>6 kg HC/T rock) and higher production indices (>0.09) are generally located in structurally low areas at depths of 2,500 to 5,300 feet.

Oil Generation from New Albany Shale: Quantification of Expelled Versus Produced Hydrocarbon, *Oltz, Crockett* This study of the Upper Devonian New Albany Group, the primary source-rock for Illinois Basin hydrocarbons, is being designed to integrate geochemical and production data with maturation and migration modeling. Creation of a database relating input from the (many) prior investigations of the New Albany Shale is the initial step. Utilizing these data to create and enhance models for maturation and migration of hydrocarbons is the goal of the study, leading to a more accurate evaluation of the New Albany Shale's contribution to producible hydrocarbons in the Illinois Basin and to the understanding of hydrocarbon migration routes. This knowledge may then be applied to exploration strategies in the basin.

Geochemistry of Natural Gas, *Riley, Coleman, and Liu* As part of the gas and gas/oil well testing program, samples of natural gas are analyzed quantitatively by gas chromatography to determine composition, specific gravity, and Btu value. Isotopic analyses are also performed on certain samples. During the report period, 133 natural gas samples were collected in the field or submitted by gas producers for precise analysis. The information gained from these analyses aids the gas producers, assists in distinguishing natural gases from contrasting sources to help solve both production and environmental problems, and adds to the Illinois data base.

A study was completed last year on methane in the glacial deposits and shallow Paleozoic sediments of Illinois. This methane, which is predominantly of microbial origin, is virtually ubiquitous in the groundwaters of Illinois based on chemical and carbon isotopic compositions of several hundred gas samples collected from private and municipal water wells. Under certain circumstances, small gas deposits accumulate within the glacial drift. These deposits provide a

unique opportunity to study the inorganic components of the gas because samples collected from gas wells producing from these reservoirs are not subject to the atmospheric contamination generally encountered when collecting gases from water wells.

A selected set of samples of gas from glacial drift sites has been analyzed for the hydrogen isotopic composition of methane and the carbon isotopic composition of carbon dioxide. These data provide insights into the mechanism of methane formation and the cause for the extreme isotopic range observed for the isotopic compositions of microbial methane. The results of this research were presented as an invited paper at the "Symposium on the Origin of Methane in the Earth's Crust" in Phoenix, Arizona, on October 25, 1987. The paper entitled "Microbial Methane in the Shallow Paleozoic Sediments and Glacial Deposits of Illinois" has now been accepted for inclusion in the proceedings of the symposium in a special issue of Chemical Geology.

***Hydrocarbon Maturation Modeling in the Illinois Basin**, Oltz, Crockett* A computer program utilized for Lopatin maturation modeling with several variables has shown that maturation of hydrocarbons in the Illinois Basin does not follow a simple linear heat-flow with time. Variations in geothermal gradient, transient heat pulses or substantially different burial histories are possible explanations. Constraints on reaction kinetics and more complex geothermal gradients are being integrated into an upgraded software program.

***Evidence of Oil Migration**, Hughes, Warren, Moore, Crockett, Seyler, Glass, and Austin* The discovery in the past year of a method to differentiate detrital from diagenetic illite represents a major advance for this project. This discovery helps to identify the potential of an argillaceous rock unit to produce diagenetic water that may help to transport oil to reservoirs. The method also aids in the resolution of several other geological problems because detrital and provenance effects can be distinguished from post-burial alteration.

Oil and Gas Database Management

***Oil and Gas Well Database Development**, Lecouris, Yeko, Alinger, and Denhart* Plans are being developed to assemble and combine ISGS well data bases into a single cohesive data base accessible by both Survey staff and the general public. Conceptual design requirements for the system (Conquest) were completed for Oil and Gas applications and several personal computer prototype software programs were developed. Programs for permit entry and mail entry are being tested in the Geological Records Unit.

***Seismic Acquisition**, Oltz* Guidelines for accepting donations of seismic record sections have been developed. Donated sections continue to be useful to ISGS staff for deciphering the Illinois subsurface in and adjacent to existing oil fields and below depths from which oil and/or gas have yet to be produced. A committee has been formed to solicit contributions from industry sources.

***Computerization of Gas Flow Reports**, Riley* Flow testing of gas and gas/oil wells has been conducted by the ISGS since the 1930s. These flow reports are being entered, on a time available basis, into a computerized database to provide convenient access to the information. All the natural gas analyses and 5 percent of the gas flow reports have been entered.

Oil and Gas Technology Transfer and Information Services

***Pool Studies Geological and Engineering**, section staff* An atlas is being compiled to present geologic and engineering studies on a field-by-field basis.

***Reservoir Characterization Short Course**, Oltz and Conley* Two research geologists, Drs. Noel Tyler and Jerry Lucia of the Texas Bureau of Economic Geology, presented a seminar and roundtable discussion on reservoir characterization for improved oil recovery from heterogenous reservoirs on May 2 and 3, 1988. The seminar was attended by 14 members of the ISGS staff, 3 industry representatives, and 10 participants from the Department of Geology at the University of Illinois.

OTHER ENERGY SOURCES

Coal Gas

Gas Accumulation In Abandoned Coal Mines, *Whitaker* Methane gas, which accumulates in the sealed rooms of abandoned coal mines, is a tempting and viable target for small communities and individual citizens who desire to use it as an energy resource. A study has been initiated to describe the reasons for and distribution of gas accumulations in abandoned mines and to alert drillers of the potential hazard that exists when drilling near or through abandoned coal mines.

Geothermal Energy

Geothermal Energy Resources In Illinois, *Larson* Thermal energy storage utilizing ground-coupled heat pumps and groundwater heat pumps is an emerging technology being employed in Illinois to provide greater efficiency in residential and commercial space heating and cooling. A new methodology for mapping favorable areas for thermal energy storage systems has been developed at the Survey. Preliminary results are now available and will be presented at an international conference in October 1988.

INDUSTRIAL MINERALS AND METALS

The industrial and metallic mineral resources of the state of Illinois have played a fundamental role in the state's position of economic leadership among midwestern states, providing adequate supplies of crushed stone (limestone and dolomite) and sand and gravel for aggregate to be used in industrial, residential and public construction projects; limestone and clay for cement; silica sand for glass; clay for brick, pottery, porcelain, and absorbent products; and fluorspar for steel-making, aluminum processing, and many chemical applications.

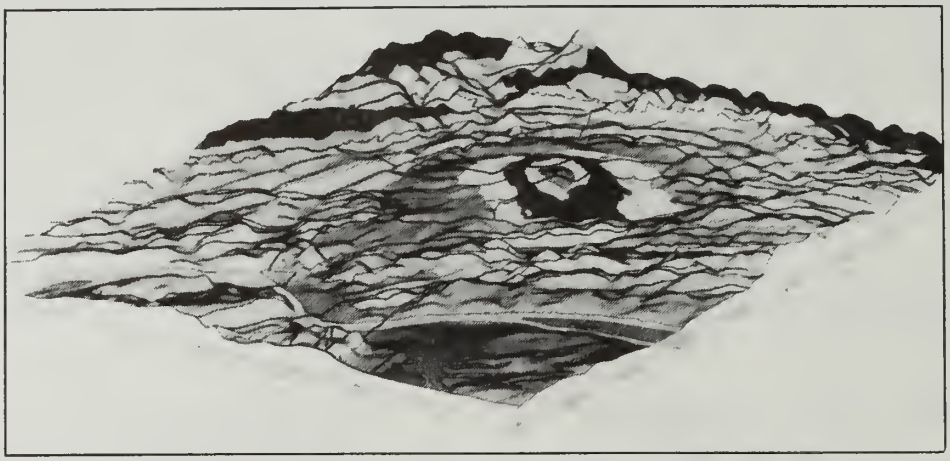
The Geological Survey's mission in studying industrial minerals and metals is to provide basic geological information to assist in the exploration, development, and production of Illinois mineral deposits to achieve the best use of the state's resources with minimal adverse impact on the environment. This requires a combination of research and service activities and interaction with industry and other state agencies, including the Illinois Department of Transportation, Department of Mines and Minerals, Department of Conservation, and Department of Commerce and Community Affairs. Recent and current research projects have investigated characteristics of aggregate materials that lead to failure of Illinois highways, sources of construction aggregate for urban and/or rapidly urbanizing areas in the state, expansion of underground mining in areas where this method would be environmentally preferable to quarrying, and assessment of the mineral potential of southern Illinois. Cooperative projects with the U.S. Geological Survey are defining areas that merit exploration for new deposits of fluorspar, lead, zinc, rare earth and related minerals.

Mineral Resource Assessments

Paducah CUSMAP, *Eidel and staff* As a cooperative project between the USGS and the Geological Surveys of Kentucky, Illinois, Indiana, and Missouri, the objective of this mineral assessment program is to compile existing geological, geophysical, and geochemical data, identify and acquire information to fill gaps in the database, and complete an in-depth evaluation of the fluorspar, barite, base metal, beryllium, thorium, rare earth, industrial minerals, oil and gas, coal, and groundwater potential of Illinois and adjoining states south of the 38th parallel of latitude within the Paducah quadrangle. Progress on some of the individual tasks has been as follows:

- ***Insoluble Residue Study,*** *Baxter, Masters, Eidel, and R. and S. Erickson (U.S.Geological Survey)* Approximately 2,400 insoluble residue samples from 36 subsurface borings in the Paducah quadrangle were prepared for 31-element spectrochemical analysis. Of these, about half were cut from insoluble residues on file at the samples library; the remainder were new insoluble residues made for this study. All samples were shipped to the USGS for analytical work.

- ***Heavy Mineral Study,*** *Masters, Dreher, Baxter, Eidel, and Mosier (U.S. Geological Survey)* As part of a cooperative USGS study of the geochemistry of the Mt. Simon (La Motte) Sandstone



Bedrock map generated by the Geographic Information System (GIS) for the CUSMAP pilot study.

and its role as a passageway for mineralizing fluids, the ISGS is carrying out a study of the heavy minerals collected by bromoform and panned separations from samples taken from wells in the Illinois Basin. Identification of the minerals will facilitatae the differentiation of epigenetic elemental and mineral suites from detrital suites.

• ***Mineral Identification in Acid Insoluble Residues,*** *Hughes, Moore, and Warren* The fine material from the insoluble residues prepared for this study were retained and samples prepared as oriented aggregates; X-ray diffraction tracings were then made of the air-dried and ethylene glycol solvated states. The tracings were interpreted to identify minerals and their approximate proportions.

• ***Mines and Prospects,*** *Baxter, Bradbury* A map and database providing locations and information on all known mines and prospects is being prepared using ISGS files, the USBM MILS listings of mines and prospects, and the USGS MODS listings prepared previously for the Strategic and Critical Minerals Program. During the reporting period, ISGS reviewed and made extensive corrections and additions to the SCM data.

• ***Geographic Information System Pilot Study,*** *Pool, McKay, Krumm, and T. Johnson* This task is the first major implementation of the Survey's GIS for mineral assessment. A pilot study to evaluate the feasibility of combining data sets of the several state surveys and the USGS was completed in August of 1987. Procedures and products were reviewed, and the methods developed during the pilot effort were adopted for the rest of the five-year project. Maps produced for the pilot study have been presented at the ARC/INFO Regional Users Conference and the American Society of Photogrammetry and Remote Sensing regional meeting. Copies of the pilot study maps have been requested by the USGS for demonstrating the usefulness of the GIS approach.

• ***Bedrock Geologic Map,*** *Nelson, C. Treworgy, and Damberger* Compilation of the bedrock geology for the Paducah 1° x 2° sheet by Nelson was well advanced by the end of the report period. Three 7.5-minute quadrangles in Missouri are currently being mapped by geologists from the Missouri Geological Survey. The bedrock map for Kentucky was previously completed. A written report on the stratigraphy and structural geology of the map area is in preparation. Information to complete databases needed for generating the planned coal resource and quality maps was collected.

• ***Pleistocene Deposits and Stack Map,*** *Berg and Keefer* The Pleistocene deposits of the Paducah Quadrangle are being mapped by the ISGS as part of the Paducah CUSMAP program. In addition, the Paducah Quadrangle portion of the computerized state stack unit will be produced at CUSMAP scale and modified. Data will be field checked and revised in the fall of 1988. The two maps will be sent to the Missouri Geological Survey for editing in January 1989.

• ***Subsurface Studies,*** *Kolata, Sargent, J. Treworgy, and Maynor* This segment of the Conterminous U.S. Mineral Appraisal Program (CUSMAP) is intended to provide isopach, structure, and lithofacies maps as well as cross sections of the sedimentary rocks in the subsurface of the Paducah 2° sheet. Stratigraphic data were compiled in the Paducah CUSMAP pilot study area (Herod, Karbers Ridge, Rosiclare, and Shetlerville 7.5' quadrangles) and entered into a stratigraphic database.

Midcontinent Strategic and Critical Minerals Program (MSCMP): Phase III, *Baxter, Kolata, Sargent, Maynor, J. Treworgy, and Hageman* The MSCMP is an ongoing cooperative project with the USGS for which the ISGS has contributed various maps and cross sections to a midcontinent compilation by the USGS. The Midcontinent area of interest to the USGS includes all or part of 12 states. The purpose of the USGS project is to assess the mineral potential of basement and overlying sedimentary rocks. The ISGS has prepared a series of maps showing the thickness, distribution and lithologies of selected stratigraphic units in Illinois. During the past year, maps showing the distribution and zero-edge of the major shale units were prepared at a scale of 1:1,000,000. This series of maps includes the Davis, Glenwood, Spechts Ferry, Maquoketa, New Albany, and Warsaw Shales and basal Pennsylvanian Shale. A second series of maps was prepared at a scale of 1:1,000,000 that shows the thickness and limestone/dolomite ratios of the Bonneterre/Eau Claire and Ottawa carbonates.

Limestone and Dolomite Resources

Inventory of Active and Abandoned Quarry Sites in Cook County, *Mikulic and Adams* The abandoned and active quarry sites of Cook County are being inventoried. The location, size, depth, history, and geological features of each quarry site is being determined. Detailed maps of these sites will be produced. This work will aid in locating new quarry sites, developing operating sites, understanding the local geology, and investigating potential environmental problems of abandoned sites. Extensive study of historical information during the past year has produced a considerable amount of new information on the location and development of local quarries. This new information has allowed a more detailed understanding of individual quarry sites to be developed and a more comprehensive history of the quarry industry has resulted, providing an essential database for geological analysis.

Chicago Stone Industry, a Historical Perspective, *Mikulic* A paper on the history of the Chicago stone industry was presented at the 23rd Forum on the Geology of Industrial Minerals in May 1987 in Aurora, Illinois. This paper describes the historical development of Chicago's stone industry as it related to changes in technology, transportation, and economics. These factors, in conjunction with the geological features of the area, have controlled and continue to control the character and composition of the stone industry, which has been a major factor in Chicago construction. During the reporting period, additional information on this subject was gathered and a manuscript for inclusion in the Proceedings of the Forum was written and reviewed for publication.

Aggregate Resource Analysis, Northeastern Illinois, *Mikulic* The production of aggregate for construction is a major industry in the Chicago metropolitan area. Although local sources have generally been adequate, depletion of known resources and urban encroachment upon undeveloped sites have resulted in an uncertain future of the aggregate industry. Of 20 quarry sites in and adjacent to the Chicago urban corridor, seven have been abandoned and only four have room for significant lateral expansion. The goals of this project are to locate additional local sources of aggregate and fully utilize existing reserves through a better understanding of the local geology. During the past year, a number of cores have been logged in the area and several

sections have been measured. A database is being constructed to develop a more comprehensive knowledge of local geology in the study area.

Possible Underground Mining of Limestone and Dolomite in Central Illinois, *Baxter* Counties in central Illinois have little or no production of either limestone or dolomite for use as aggregate in Portland cement and bituminous mixtures. The area with paucity of quarriable rock includes major downstate metropolitan areas: Champaign-Urbana, Springfield, Decatur, Peoria, and Bloomington-Normal. A possible source of high quality stone for these uses exists in the relatively deep subsurface of the area.

In a paper prepared for oral presentation at the 23rd Forum on the Geology of Industrial Minerals, the feasibility of mining by means of vertical shafts was discussed. Possible targets for underground mining are carbonate rocks of the Ste. Genevieve-St. Louis, and Burlington Limestones, the Devonian-Silurian Hunton Megagroup, and Galena Group. A report on this subject was completed during the reporting period and will be published in the Forum Proceedings.

Susceptibility of Selected Carbonate Rock Aggregates to "D-Cracking," *Baxter, Harvey, Hughes, Warren, and Masters* This is an on-going cooperative project with the Illinois Department of Transportation, Division of Highways, Bureau of Materials. IDOT is seeking means of predicting how different carbonate rocks will react under freeze-thaw testing and how this test relates to performance in concrete and asphalt mixes. During the reporting year, we provided chemical and clay mineral analyses on 12 different carbonate rock sources and began petrographic studies of thin sections of aggregate from those sources.

Acquisition/Study MSDGC TARP Cores and Seismic Data, *Eidel, Mikulic, Zelinsky, and Glogowski* For the past several years, ISGS has been trying to find means of logging, collating and transferring the essential portion of in excess of 200,000 feet of core drilled in connection with the construction of the Metropolitan Sanitary District of Greater Chicago's tunnel project (TARP). These will be valuable for evaluating construction aggregate resources of the Chicago area, the feasibility of underground mining of dolomite, and creation of underground space and other engineering and geochemical problems that could arise in the metropolitan area. MSDGC has announced that they have no further need to store these materials. Together with seismic data donated by MSDGC, the cores represent 80 percent of the Chicago urban corridor. During the present reporting period, the MSDGC storage warehouse in Skokie was visited to determine the status of the core and space required. The height of pallet stacks, number of core boxes per pallet and size of pallets were determined. A proposal for a $308,000 core storage facility in Champaign was submitted for the consideration of the Capital Development Board.

Sand and Gravel Resources

Effects of Different Kinds of Rocks in Illinois Gravels on Concrete Beams during Multiple Freeze and Thaw Tests, *Masters* A written report and talk was given on this project at the Forum on the Geology of Industrial Minerals in May 1987 at Aurora, Illinois, based on ISGS Contract/Grant Report 1987-I, *Geologic Characteristics of Illinois Gravel Deposits Affecting IDOT Freeze-Thaw Test Results.* Research results indicated that chert, especially low specific gravity (<2.35) chert, and ironstone, along with silty dolomite, and possibly weathered carbonate cause more expansion of test-beams subjected to the freeze-thaw test (ASTM-C666) than other kinds of rocks in the samples.

Silica and Industrial Sand

Separation of Kaolin Clay from Silica Sand Waste Streams, *Baxter, Bhagwat, Ehrlinger, Khan, Masters, and Hughes* In 1968, Industrial Mineral Note No. 36 was published describing the presence and possibility of separation of kaolin from fine- grained silica sand cut from the waste streams of the silica sand producers in Illinois. Two years ago the economics of such a secondary recovery operation was determined.

Since 1968, demand and freight prices for kaolin from southeastern United States have increased. Also, the production techniques for separating kaolin have changed. The change in the nature of discarded material, and market conditions have necessitated a new examination of processing behavior and new determination of economics of the revised process. The purpose of the present study is to determine the merits of the new process and provide samples of the product for economic appraisal.

Clay Mineralogy and Clay Resources

Clay Mineral Business, *Hughes, Moore, Glass, Warren, Krumm, and Taylor* Support of clay-mineral-based industrial activity in the State of Illinois included a number of consultations, analysis of samples, phone conversations, and the assembling and sending of operation-related data. Specific examples include: 1) preparation of a report covering Bond, Clinton, Madison, Monroe, Randolph, St. Clair, and Washington Counties at the request of the Southwestern Illinois Planning Commission (SWIMPAC) in support of their efforts to attract a brick and tile manufacturer, 2) analysis of samples for H. Dane Kelly of Marseilles to estimate the commercial value of the gypsum in two sources--stockpiled gypsum and abandoned waste ponds, and 3) analysis of samples from Pope and Hardin Counties for three parties interested in selling kaolin or producing clay products from their kaolins.

Fluorspar and Metal Resources

Subsurface Geochemical Investigation in Western and Southern Illinois: A Pilot Study, *Baxter, Masters, Eidel, and R. and S. Erickson and B. Chazin (U.S. Geological Survey)* This project is a cooperative effort between the ISGS and the USGS. The work and report detailing the results were completed and reported in the last annual board report. During the present reporting period, the report was published as Illinois Mineral Note 98. Extension/expansion of these studies is being undertaken as part of the Paducah CUSMAP project (see Paducah CUSMAP insoluble residue studies).

The authors suggest that at least four different ore deposit models should be considered in prospecting for mineral deposits in western and southern Illinois: (1) Ordovician-hosted and possibly Devonian-hosted zinc-lead deposits similar to those of the Upper Mississippi Valley Zinc-Lead District, (2) New Mississippian-hosted fluorite, barite, zinc, and lead deposits in southwestern Illinois similar to those in the Illinois-Kentucky Fluorspar District, (3) Cambrian-hosted lead deposits similar to those in the world-class Southeast Missouri Lead District, and (4) cryptoexplosion breccia-hosted deposits (Be, Nb, Y, Th, Ba, F, and REE) similar to known deposits at Hicks Dome in Hardin County, Illinois.

Igneous Rocks of the Fluorspar District--Intrusive Breccia at Hicks Dome, Hardin County, Illinois, *Bradbury, and Baxter* Intrusive breccia at Hicks Dome are believed to have been formed by explosive release of gases from a deeply buried alkalic magma, an agency also responsible for the approximately 4,000 feet of uplift related to the dome. Approximately 45 breccia bodies have been mapped in the immediate vicinity of Hicks Dome. Most are nearly vertical dikes up to 10-feet wide; some are bodies of undetermined shape. Some breccia exposures are weakly mineralized. Mineralized breccia (F, Pb, Zn, Ba, Nb, Be, Ti, Th, and REE) is known to occur at depth. A report describing the Hick Dome breccia and mineralization and discussing their modes of origin has been recently revised and will soon be peer reviewed.

Geochemistry of Phosphate Nodules in Paleozoic Midwestern Black Shales, *C.-L. Chou, J. Frost, and N. Shaffer (Indiana Geological Survey) and R. M. Coveney (University of Missouri at Kansas City)* The purpose of this project is to study the mineralogy and geochemistry of discrete phosphate nodules in metalliferous black shales of Devonian-Mississippian and Pennsylvanian ages in the midwestern United States. Twenty-four phosphate nodules from the New Albany Shale and six from Pennsylvanian shales were analyzed for mineralogy and trace elements. These samples are composed mainly of carbonate fluorapatite, and are enriched in several trace elements. Zinc and uranium are especially abundant. Rare earth element patterns,

normalized to shales, showed negative cerium and slightly positive europium anomalies. Phosphate nodules formed during the diagenesis of the black shales, and trace elements were incorporated into the nodules during their formation.

Subsurface Geochemistry of Illinois Cambrian Sandstones: A Pilot Study, Masters, Dreher, Steele, Baxter, Eidel, and *Mosier (U.S.Geological Survey)* This study began with the selection of Cambrian sandstone samples from well cuttings and cores from test holes that were included in the pilot study of the geochemistry of acid-insoluble residues from carbonate rocks in western and southern Illinois. The sandstone samples are dissolved in a sequence of acids and the solute from each analyzed for trace element and heavy metal content by the USGS in Denver. Cluster analyses on the USGS chemical data revealed some trends and suggested certain mineralogical associations, but there were too few samples for firm conclusions.

Mineralogical analyses will also be carried out on high-specific-gravity concentrates from the bulk samples in an attempt to identify which elements are in detrital minerals deposited with the sand and which are in epigenetic minerals related to mineralization. These studies are designed to further the assessment of the mineral resource potential in Illinois. Study of these sandstones that occur below platform carbonates may provide information on the migration of trace metal bearing fluids and loci of carbonate-hosted ore deposits.

Beneficiation/Processing

Cost of Energy Consumed in Grinding Limestone and Dolomite, *Khan and Baxter* Grinding, required to unlock and liberate interlocked minerals before they can be isolated from each other and cleaned, is an extremely cost intensive step of mineral processing operations. Research efforts are being made to reduce the cost of grinding of minerals by improving grinding efficiency of the mills and minimizing the consumption of energy. To determine the impact of grinding conditions on the energy consumption, limestone and dolomite will be ground using chrome steel balls of different sizes in a stainless steel mill constructed in the ISGS workshop. Temperature, torque, and speed of rotation of the mill during the comminution tests will be monitored using sensors and transducer and controlled/recorded by a desktop computer.

Dispersibility of Dry Powdered Limestone for Mine Flame Retardation, *Khan and Baxter* Stone dust retards the propagation of flames during mine explosions by diluting the concentration of combustibles in the ambient air. However, powdered stone stocked in the mine for this purpose fails to do the job if it absorbs water from the humid air. Efforts are being made to make the powdered stone hydrophobic so that it does not absorb moisture and remains readily dispersible.

Powdered limestone, dolomite and/or shale will be treated by surfactants to make them hydrophobic. The treated powder will be exposed to air of different humidity for various time intervals and subsequently its dispersability will be determined by measuring the amount of infrared light it absorbs or intercepts upon dispersal. A testing unit has been constructed in-house for the dispersion tests.

Technology Transfer and Information Services

Minerals of Illinois: An Overview, *Baxter and Reinertsen* A short illustrated article with this title was requested by the editor of Rocks and Minerals magazine for inclusion in a special edition featuring the rocks, minerals, and fossils of Illinois. The article, prepared primarily for rock and mineral collectors, covered the main geological areas in which collecting of specimens is possible: surficial materials (i.e., rare native copper, gold), the coal measures (such as pyrite, marcasite, sphalerite), the Illinois-Kentucky Fluorspar District, and the Upper Warsaw in western Illinois. The special edition featuring Illinois appeared in the April-May 1988 issue of the magazine.

Industrial Minerals Publications of the Illinois State Geological Survey, *Goodwin, Mikulic, and Baxter* The purpose of this project is to revise, update, and expand the list of annotated

publications of the ISGS that have bearing on the industrial and metallic minerals of the State of Illinois. An updated version will be ready when the currently available IMN 69 becomes out of print. The revised list, arranged by commodity, has been brought up to date and entered into the NBI format. During the present reporting period, the proposed publication received peer and administrative review and is undergoing editorial review.

Underground Mining Methods: A Poster Session Comparison, *Khan* Mining operations must be carried out in a manner that ensures maximum utilization of natural resources. This entails maximum productivity, while ensuring maximum safety. To achieve these goals, mining procedures, which consist of excavation of openings (shafts, inclines, adits, service areas), development work (drifts, raises, crosscuts) and stopping operations to remove the ore, are tailored to the prevailing economic and environmental conditions. The mode of occurrence, attitude, thickness, location, distribution and value of the ore, stability of the ore and surrounding rock, availability of skilled labor and cost of support and fill material determine the selection of the appropriate mining method. The underground mining method that is utilized, therefore, varies as the physical disposition and value of the ore changes from place to place.

Various mining methods were compared and explained in a poster session to provide an understanding of the mining method and to emphasize the advantages of each method.

Mineral Industries Map of Illinois, *Masters* The Mineral industries map of Illinois, first published in 1955, revised in 1961, and now out of print, is being updated and revised. The map will be published at a scale of 1:500,000 to serve as a companion to the Geologic map of Illinois (1967) and the Quaternary deposits map of Illinois (1979). The Mineral industries map will show the locations of coal mines, oil and gas fields, limestone and dolomite quarries and mines, sand and gravel pits, cement plants, clay pits and producers of clay products, fluorspar mines and mills, fly ash sources, glass producers, silica (industrial) sand pits, lime plants, peat producers, slag sources, tripoli mines and processing plants and the locations of various metallic and non-metallic processing plants with operations based on ores and minerals imported from other states and/or recycling procedures.

X-Ray Diffraction, Identification, and Analysis Report, *Moore, Hughes, and Glass* This report is being prepared to fill the need for a modern monograph on clay mineralogy. It is currently in the hands of the publisher, Oxford University Press.

Twenty-Third Forum on Geology of Industrial Minerals, *Baxter, Masters, Mikulic, Khan, Hughes, Ehrlinger, Warren, and Goodwin* The 23rd Forum on the Geology of Industrial Minerals was held May 11-15, 1987 at Aurora, Illinois with the Illinois State Geological Survey as host. The technical program, consisting of four half-day sessions, featured the industrial mineral resources of northeastern Illinois and concluded with a tour of the Fermi National Laboratory and Accelerator. Two one-day field trips allowed visits to large dolomite quarries in the Chicago area, U.S. Silica's operation at Ottawa, Lone Star Cement Plant at Oglesby, and the Streator Brick Plant at Streator.

Seven papers authored by ISGS scientists were presented at the Forum; six of these were prepared or are being prepared for publication in the Proceedings during the reporting period: (1) The geology, history, and future of industrial clays in Illinois (Hughes, White, Warren, Glass, and Fox); (2) Evaluation of the economic usefulness of earth materials by X-ray diffraction (Warren and Hughes; (3) Chicago's stone industry: a historical perspective (Mikulic); (4) Construction aggregates industry in the Chicago Area (Bhagwat); (5) Possible underground mining of limestone and dolomite in central Illinois (Baxter); (6) Effects of different kinds of rocks in Illinois gravels on freeze-thaw test beams (Masters); and (7) Enhancement of sulfur-dioxide sorption reactivity of limestone (Rostam-Abadi, Moran, R. Frost, Harvey, and Sresty).

Twenty-Eighth International Geological Congress Field Trip to Illinois-Kentucky Fluorspar District, *Baxter and Bradbury* Two and one-half days of this trip will be devoted to the Illinois-

Kentucky Fluorspar District. In addition, the trip will include Precambrian terrain of Southeastern Missouri, the Missouri Iron Range, and the Southeastern Missouri Lead District. During the reporting period, a 30-page, single-spaced manuscript covering the Illinois portion of the trip was prepared, received peer review, and submitted to IGC editorial staff for format approval. The manuscript includes background information on the history of mining, intrusive igneous rocks, stratigraphic and structural setting, and mineral deposits of the District and descriptions of 11 planned stops at sites of geologic and/or historic interest.

The Cache Valley of Southern Illinois, DNAG-GSA Centennial Field Guide, *Masters and Reinertsen* The geologic history of the formation of the deeply entrenched Cache Valley has been detailed in a DNAG-GSA Centennial Field Guide. The origin of the Cache Valley extends back into the Cretaceous Period and is related to the origin of the northern part of the Mississippi Embayment. A stream flowing east to southeast may have occupied all or part of the location of the Cache Valley during the erosion of the Pascola Arch. Shallow marine and fluvial-deltaic sediments were deposited in most of the area of the Cache Valley, followed by period of erosion. Chert gravel deposition in the late Tertiary filled the northeastern portion of the Embayment, concentrating the major west- to southwest-draining rivers of the time into the present location of the Cache Valley. The valley was superimposed onto the bedrock by early Pleistocene (pre-Illinoisan) deep entrenchment of the major glacial drainage systems. With each glacial cycle the Cache Valley was alternately scoured out and refilled with sediment to varying heights and thicknesses. The shallow sediments underlying the Cache Valley are mostly late Wisconsinan and Holocene in age (12.6 to 8.2 ka), bracketing the time of the diversion of the Ohio, Cumberland, and Tennessee rivers from the Cache Valley into the present Ohio Valley.

Special Projects

Illinois Stone for Constitutional Monument, Philadelphia, Masters and Reinertsen At the request of Governor Thompson, a suitable stone was located, cut, finished (4' x 2' x 2'), and shipped to Philadelphia, Pennsylvania to become part of the bicentennial tribute to the U.S. Constitution. Since Illinois has no building stone industry, a lengthy search of rock quarries was necessary. The final stone was found at the McCook Quarry in Cook County of Vulcan Materials Company, which donated it to the state. The stone is from an unusually thick, homogenous bed in the Markgraf Member of the Silurian-age Joliet Dolomite. The stone is similar to dolomite beds that were extensively quarried for the Chicago building stone industry during the 1800s. Tri-State Stone Company of Frankfort, Illinois donated time and work to help select the final stone, haul it to its plant and finish it.



David L. Reinertsen, head of the Educational Extension Unit, inspects the stone that he helped to locate and arranged to ship to Philadelphia for the Illinois contribution to the Constitutional Monument.

Illinois Monument for World War II Museum, Normandy, France, *Masters, Reinertsen, and Reed* The Illinois Department of Veterans Affairs (and Governor Thompson) requested the assistance of the ISGS to find a suitable stone to cut into a 1' x 1' x 1' block to be shipped to Normandy, France for a formal garden leading to the entrance of the new "Battle of Normandy Museum." ISGS personnel located a block of the Mississippian-age Ullin Limestone from Union County, Illinois. The Ullin Limestone was once quarried as an ornamental and building stone. Jerome Lutz, a retired building stone producer, helped select the final stone, which was donated by the Columbia Quarry Company. The stone was transported to Chapman Stone Company in Springfield, which donated time and effort to finishing it.

MINERAL ECONOMICS

Market Research

Future of Illinois Basin Coal: 1994 and Beyond, *Bhagwat* A report on this subject has been published as Illinois Mineral Notes 97. The report notes that since the Clean Air Act was implemented in 1971, production of high-sulfur Illinois Basin coal has stagnated, while total U.S. coal production has continued to increase. Illinois Basin coal production figures for the years 1975 through 1985 show that low-sulfur western coals have successfully captured new developing coal markets that traditionally would have been Illinois Basin coal markets, despite revisions in the Clean Air Act aimed at reducing the disadvantage of high-sulfur coals in the marketplace. The continuing weak position of Illinois Basin coal is attributed in part to a lack of cost competitiveness. It is predicted that Illinois Basin coal production will continue to lag through 1994 and beyond if current clean air regulations are enforced and the price of Illinois Basin coal does not become competitive. If acid rain legislation is enacted, production of Illinois Basin coal will undoubtedly decrease, resulting in the loss of thousands of mining jobs.

Factors Associated with Fossil Fuel Prices in the United States: An Analysis of the 1971-1985 Period, *Bhagwat* This study analyzes the factors associated with domestic and international fossil fuel prices in the United States. Statistical correlations are supported by year-to-year dynamic price/demand analyses and literature studies. The results of the study can be summarized as follows:

- The coal prices in the 1971-1985 period could not be linked with the prices of oil or gas with an acceptable degree of confidence.

- The oil prices could be linked with cost of finding oil and gas, but were also subject to substantial short-term influence by OPEC.

- Within OPEC, the Saudi Arabian policies and the policies of other members were distinctly contradictory and prevented the OPEC from fully exploiting its cartel policies. Because of the lead time involved in raising the non-OPEC oil production, it is probable that the failure of the cartel would have come later had the OPEC members cooperated.

- The natural gas prices in the United States could be primarily linked to the effects of energy conservation manifested in the efficient use of energy in wealth creation (GNP). The gas prices could be indirectly, albeit weakly, associated with the oil prices through the oil import dependency of the United States.

- The short-term power of OPEC to disrupt world economic stability and the ability of the market forces to prevent OPEC success in the long term could have important foreign policy and foreign aid implications for industrialized countries. Policies designed to increase world-wide availability of oil could deprive the OPEC cartel of the short-term disruptive powers and create powerful trading partners for the industrialized nations.

Carbon Monoxide/Ethanol Desulfurization of Coal: A Preliminary Economic Review, *Bhagwat and Schaschwary* Detailed study of substances generated in this process of coal desulfurization is underway. The aspects to be covered will include past, current, and future market prospects for low-sulfur coal, an oil-like substance, acetaldehyde, hydrogen sulfide, carbonyl sulfide, and sulfur. Preliminary results indicate that hydrogen sulfide and carbonyl sulfide would have to be converted to sulfur for marketing. Acetaldehyde markets are declining; however, its future use for production of a deicing agent is being investigated. The oil-like substance would have to be refined; therefore, literature discussing refining problems is being reviewed.

Modeling the Construction Aggregates Demand and Supply: A Chicago Area Case Study, *Bhagwat* Construction aggregates--sand and gravel and stone--represent a $400 million industry in Illinois. Because of their low unit value, the construction aggregates are usually sold within 50 miles of the place of production. Local economic and demographic situations, therefore, have a large effect on the aggregate industry. National economic factors as well as political decisions can also influence construction activity and affect the aggregate production. If future aggregates demand could be successfully predicted, the industry and the economy as a whole would benefit from minimized price fluctuations. Econometric models to predict future aggregates production attempted in Oregon, Ontario, and California indicated that regional conditions differ significantly enough to warrant development of regional models. This paper attempts for the first time to develop such a model for Illinois. With two-thirds of Illinois residents living in the Chicago area, the region appeared to be a natural choice for such a study. Based on demographic and economic information on the six counties in the Chicago area, econometric models indicate population, employment, gross state product, and mortgage interest rates to be the most significant factors affecting aggregate production. Short-term projections made with the help of the models turned out to be within 5 percent of actual production. However, the models' statistical reliability is low and the correlations cannot always be logically explained. Further research is essential, and it is believed that detailed community-level data gathering, especially on public construction projects, could improve the models significantly.

Potential Uses for Material to be Excavated from the Proposed Illinois Superconducting Super Collider Facility, *Curran, Bhagwat, and Hindman* This study examines potential uses for the material that would be excavated if the proposed Superconducting Super Collider (SSC) is built in northeastern Illinois. Environmentally and economically sound uses for the excavated material are identified.

Of the construction options that were considered, placing the SSC in an underground tunnel was judged to be the best plan for minimizing impact on the cultural and natural environments. The tunnel will be placed in dolomite, which provides an excellent tunneling medium. About 94 percent of the dolomitic material excavated during construction of the facility would be dolomite and dolomitic limestone. The remaining 6 percent would consist of dolomitic shale, glacial till, and sand and gravel. The expected total amount of material to be removed is about 4.1 million cubic yards (4.6 million tons). About 59 percent of this material would be produced by tunnel boring machines, about 38 percent would come from drill-and-blast excavation, and about 3 percent would be produced by clam-shell excavation of the glacial materials. Five potential uses for the excavated material have been examined:

- use or storage in sand and gravel pits and rock quarries;
- restoration of the Kaneville Esker;
- landscaping around SSC campus and service areas;
- use in local forest preserves;
- use in local landfills.

Pits and quarries could easily accommodate all of the excavated material. (A survey indicated that the local aggregates operators would be willing to accept eight times the amount of material to be excavated from the SSC.) Restoration of the Kaneville Esker and landscaping could each use much less than the total 4.1 million cubic yards. All five options are environmentally sound and would benefit the surrounding communities.

Extraction Research

Secondary Recovery of Coal Fines: An Environmental and Economic Cost/Benefit Analysis, *Bhagwat, Baxter, Khan, Curran, and Rice* Under a $42,000 research grant from the Illinois Department of Energy and Natural Resources, investigations are being conducted to determine the costs involved in secondary fine coal recovery and environmental benefits of such recovery. Samples of coal slurry effluents from two coal cleaning plants and one slurry pond have been analyzed. Results of a plant-by-plant survey and the laboratory experiments conducted by the investigators indicate possibilities of three flowsheet designs for the fines processing. Cost data on equipment have been gathered. A software program for use with microcomputers is being developed to assess the economic feasibility of the undertaking. The aim is to provide a tool to operators in order to enable them to conduct their own feasibility analysis. Environmental benefits such as land saved from ponding could be obtained at much reduced or no costs if secondary recovery proves economically feasible. The final report will be ready later this year.

Technology Transfer and Information Services

Course in Mineral Economics at the University of Illinois Urbana/Champaign, *Bhagwat* A senior level course in mineral economics is being prepared for the fall semester 1988. The course is intended for engineering students primarily from material sciences fields. The course contents are patterned after specialized studies in mineral economics at major U.S. universities. The course is unique in that it combines elements of macroeconomics, microeconomics, resource economics, evaluation of investment decisions, and forecasting into one for students of engineering, unlike the separate courses in each of these subjects taken by students majoring in mineral economics. Student response during preregistration has been encouraging.

Environmental Geology Research and Service Programs

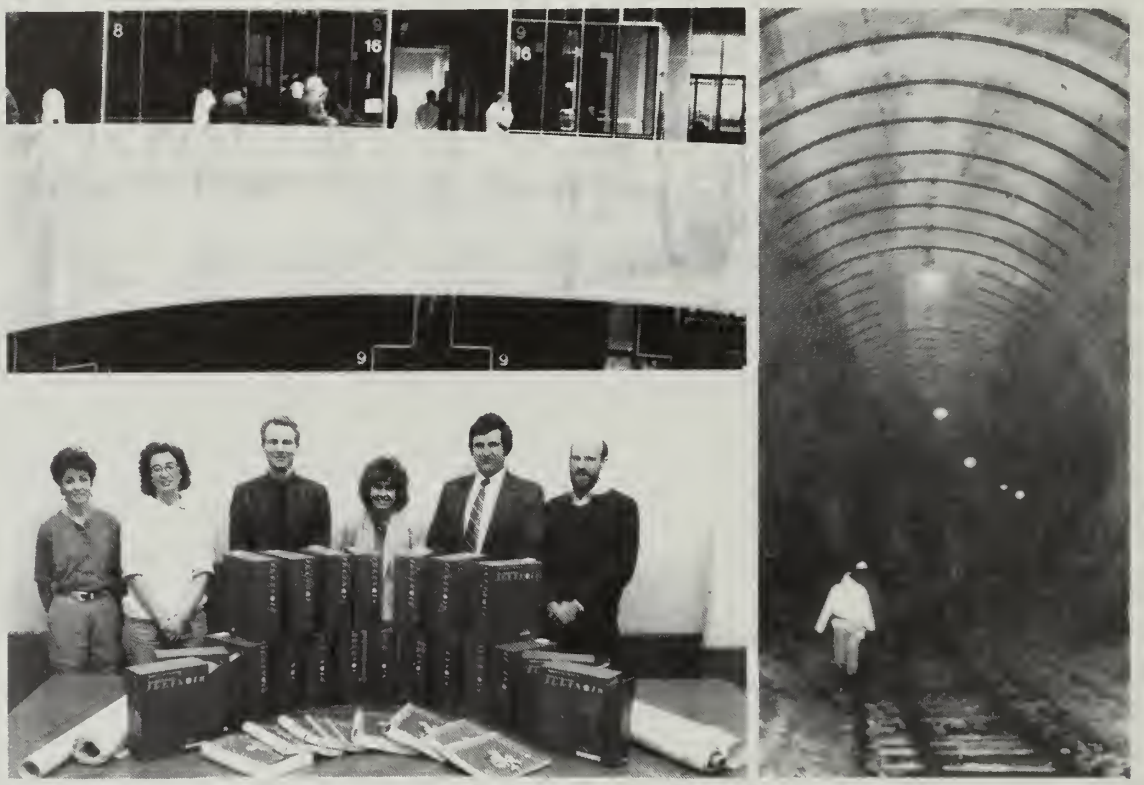
ENVIRONMENTAL GEOLOGY RESEARCH AND SERVICE PROGRAMS

The Environmental Geology Program develops and interprets basic geologic data that can help government, industry, and the public make informed decisions and take appropriate actions to protect and enhance the natural environment and wisely develop the state's mineral resources.

Research and service elements of the program focus on locating and protecting groundwater resources, managing wastes, siting facilities in Illinois, monitoring lakes and rivers, studying natural and manmade geologic hazards (such as landslides, earthquakes, and mine subsidence), and suggesting ways to mitigate the effects, and conducting land-use planning studies.

ENVIRONMENTAL STUDIES AND ASSESSMENTS

In 1984, the Environmental Studies and Assessment program was organized to help industry, institutions, and government agencies assess and locate suitable sites for facilities in Illinois, carry out environmental impact studies, and identify cost-effective mitigation procedures in siting efforts. In the last year, emphasis was placed on three projects. The first, siting the Superconducting Super Collider (SSC) in Illinois, a $4- to 6-billion dollar project, involved several sections of the Illinois State Geological Survey (ISGS) and other divisions of the Illinois Department of Energy and Natural Resources (DENR). The second project, initiated this past year, is a geologic study of the site on the Argonne National Laboratory campus for the planned 7-GeV Advanced Photon Source--a $300-million synchrotron. The ISGS also aided the Office of Surface Mining and the Illinois Department of Mines and Minerals in constructing databases for the Lands Unsuitable for Mining Program and the mine permitting process. Additionally, efforts were carried out to determine long-term impacts of human activities on major Illinois lakes and streams.



Illinois welcomes U.S. DOE's task force, which visited the proposed SSC site near Batavia in March 1988 *(upper left)*. Members of the ISGS task force for siting the SSC proudly present the extensive collection of publications and maps reporting the geological, environmental, and socio-cultural suitability of Illinois for the proposed SSC *(lower left)*. The TARP tunnel *(right)* is representative of the tunnel proposed for the SSC.

Special Siting Studies--the Superconducting Super Collider (SSC)

The three Scientific Surveys--Illinois State Geological, Natural History, and Water Surveys--began working in 1983 to determine the feasibility of locating the SSC in Illinois. Promising results led to a coalition of forces in 1984 to pursue the project. By 1985, the program had become about a $1-million-per-year effort for the three Surveys. Illinois has worked steadily on the SSC program for almost 4 years. The visible milestones surfaced mostly last year:

September	The state submitted its proposal to host the SSC; and the ISGS provided major input into the massive set of documents.
October	The Illinois site survived the first cut.
December	Illinois was included on the short list of seven "Best Qualified Sites."
January	The state released the full proposal to the public and engaged in a series of public meetings; ISGS staff assisted in these meetings.
March	The ISGS also helped to host a site visit by the Environmental Impact Statement (EIS) writing team and again provided major input in the submittal of environmental data on Illinois, a submission larger than the original proposal. By this time, Illinois' proposal and environmental information documents filled 4 feet of shelf space.
April	ISGS staff worked extensively with the EIS writing team.
May	The ISGS helped to host the official U.S. Department of Energy (DOE) site visit.
June/July	ISGS staff finished many technical reports and initiated preparations for tours to neighboring states, and briefing sessions in Washington. Preparations began for the state's response to the draft EIS targeted by DOE for late August. The DOE decision on the preferred site is expected in November or December.

ISGS efforts have yielded a comprehensive set of high-quality natural resource data for a significant portion of Illinois that is enjoying rapid urban development. The ISGS is continuing its efforts to publish these data in the scientific literature. It has noted that dividends from the expanded database for this region of the state will be enjoyed for many years, regardless of the results of the SSC siting decision.

The support enjoyed by the Surveys for the SSC work--whether measured by quality of people, administration, dollars, or interagency cooperation--has been superb.

Geological-Geotechnical Studies *Kempton, SSC Geological Task Force* Major activities and contributions of the SSC Geological Task Force Team can be listed as follows: 1) completed the text and figures for Volume 3, 2) prepared several publications on the geological, geotechnical, and hydrogeologic aspects of the SSC site, 3) contributed to the EIS submitted to DOE, 4) contributed to and participated in the RTK and DOE site visits, including the leading of geological field trips and conducting office and lab conferences with their technical experts, 5) participated in the DOE scoping meeting and numerous public meetings, and 6) continued studies on the SSC site including hydrogeologic investigations, seismic reflection surveys, and determining geotechnical characteristics of the bedrock and drift.

Of special note were staffs' efforts to provide text and illustrations for Volume 3, Geology and Tunneling for the state's site proposal. Working with Illinois Institute of Technological Research Institute (IITRI--the state's proposal writer) and Harza Engineering Company (a consultant to the state), the Geological Task Force provided the bulk of the data and text and then worked with Harza Engineering to review and edit the volume. The volume is divided into five sections:
1) General (location and SSC profile), 2) Geology (including data sources), 3) Geohydrology (with contributions by the State Water Survey), 4) Seismicity and faulting, and 5) Tunneling and underground construction.

Illinois Proposal for the SSC *Gross, SSC Environmental Screening Task Force; and Kempton, SSC Geological Task Force* On September 2, 1987, Illinois submitted to the U.S. Department of Energy a proposal to host the SSC. DOE received 42 other proposals. The state's proposal consisted of eight volumes and a dozen attachments, totaling about one foot of shelf space.

Most of the content was prepared by the three Surveys. The ISGS graphics staff prepared 448 original illustrations, and the print shop printed the 130 copies needed of most of the attachments. In October, DOE determined that 36 of the 43 proposals were "responsive" to the invitation and forwarded those 36 to a committee of the National Academy of Sciences/National Academy of Engineering. In December, the committee reported a Best Qualified List of eight, including Illinois.

Illinois Submission of SSC Environmental Data *SSC Geological Task Force; SSC Environmental Screening Task Force* With the news in December 1987 that the Illinois site was one of only seven under consideration for the SSC, the state officially received four sets of requests for environmental data. One of these sets of questions, Appendix D, had been published in April 1987 as common to whatever states might be included on the Best Qualified List. Two additional sets were common to all states, and the third additional set was specific to Illinois. Using Harza Engineering and IITRI as compilers, the state prepared these materials. The effort was every bit as large as the original SSC proposal.

The principal environmental submission was made on March 14, 1988, with additional information being submitted on March 30. The basic materials consisted of six volumes bound into seven books. Additional supporting documents, filling 20 boxes, were also provided. The master copy of materials is now in the ISGS SSC Archives.

Environmental Assessment for the SSC *Gross et al.* Because the environmental data compiled for the Federal Draft Environmental Impact Statement was so very large (20 boxes) and mostly in a question/answer format, the state elected to do a voluntary submission to provide some meaning and some mitigation ideas appropriate for Illinois. The result, mostly written by Harza Engineering and IITRI, with substantial input from the Scientific Surveys, is a 125-page manuscript published as Volume 3, Environmental Assessment.

Geotechnical Studies for the SSC *Bauer, Hasek, and Su* Strength testing was completed on the core extracted from the first 17 exploration holes, and geotechnical logging was completed on about 3,500 feet of core from boreholes 18-30. Strength testing is being performed on the various types and fillings of joints encountered in the five formations and on large-diameter core. Also, measurements are being made on the thermodynamic properties of these formation. All the geotechnical characteristics for boreholes 18-30 were compiled for the drilling report covering boreholes 18-30 (EGN 122).

A vibration monitoring study was conducted to determine the amount of vibration transmitted from truck and rail traffic down to about 60 feet below grade. The results showed that the Illinois SSC site is well within the strict vibration tolerances, even 200 slant feet (combination of horizontal and vertical) away from both vibration sources.

When all testing is completed, the results of the geotechnical studies will be published in the Environmental Geology Notes series.

High-Resolution Seismic Profiling *Heigold, Graese, and Vaiden* Detailed seismic reflection profiling was done at several locations around the proposed SSC site by Walker Geophysics of Essex, Iowa. This preliminary work provided a methodology for mapping rock interfaces relevant to the construction of the SSC; and it allowed examination and evaluation of specific faults and other geologic structures that had not been adequately described by existing borehole data and previous geophysical studies. Information from this survey was provided to RTK and DOE to show that the geology of the site was structurally and lithologically uniform. Only a few minor faults were found, generally with displacements less than 35 feet.

Reclamation along the SSC Seismic Lines *Berggren, Dodd, Schumacher, and Richter* The high-resolution seismic work done to study the rock structure for the proposed SSC ring required drilling very closely spaced holes in four lines totaling nearly 17 miles in length. Because three of the four lines were drilled in ditches beside public roads, care had to be taken to see that the

holes were properly backfilled. A program was initiated to periodically inspect the lines and to backfill partially filled holes or those having settled fillings. The program will continue until the hole fillings are judged to be stable.

Potential Uses for the Material to be Excavated from the Illinois SSC *Curran, Hindman, and Bhagwat* Disposal of the predominantly dolomitic material excavated from the Illinois SSC will not be a problem. Sand and gravel pits and rock quarries within 10 miles of the ring are willing to take eight times the amount of material that would be removed. Local governmental and forest preserve officials and landfill operators have also expressed interest in the material.

Since the initial study on spoil disposal was completed and presented with the Illinois proposal to the DOE in September 1987, this issue has emerged as one of the great public interest. Further clarification was made of the relative merits of alternatives offered by both private and public concerns: in sand and gravel pits and rock quarries, restoration of the Kaneville Esker, landscaping around SSC campus and service areas, in local forest preserves, and in local landfills. Costs of the alternative uses were examined with programs on the Geographic Information System (GIS) to estimate transportation cost from removal shafts to the destination and determine shortest and most environmentally sound routes.

This project is discussed in Environmental Geology Notes 125 and in a paper presented at the 1988 Forum on the Geology of Industrial Minerals held in Greenville, South Carolina, May 1988. An abstract describing the programs used to estimate transportation costs was accepted for the GIS Symposium to be held in Denver, Colorado, September 1988.

SSC Technology Transfer and Information Services

RTK Site Visit *Gross, Kempton, Hines, and team members* The U.S. Department of Energy, with overall responsibility for the preparation and servicing of the Environmental Impact Statement for the SSC, contracted much of that work to a west coast consulting firm, RTK. Each state provided data for the EIS to RTK. Then RTK sent a team of nine staff to Illinois for a week-long visit to review the site and the data submission. The visit was held March 21-25, 1988. Survey staff prepared documents in response to a 35-page checklist of issues. They planned and conducted a series of field trips at the SSC site and hosted meetings in Champaign to study SSC drill cores and to examine the Geographic Information System.

DOE Site Visit *Kempton, Bauer, Gross, Hines, and team members* In May 1988, a team of 23 federal officials made a week-long site visit to Illinois to examine the site and proposal for the SSC. Survey technical staff participated in the presentations to the DOE team--Bauer on geology and Gross on environmental issues. Bauer and Gross were narrators during helicopter tours of the site. Staff also assisted on tours of geological and environmental points of interest highlighting regional setting, land acquisition plans, and regional resources. Survey staff were pleased to help the Illinois team present a well-coordinated effort.

Press Information on Environmental Assessment Report for SSC *Gross* Don Etchison, Director of DENR, and David Gross introduced this publication to the press in a series of nine visits to nine newspaper editorial boards. They visited all daily newspapers in Chicago and the western suburbs.

SSC Geological-Geotechnical Publications *Kempton, Bauer, and staff of SSC Task Forces* One of the major strengths of the Illinois bid for the SSC site has been the support given to obtain the required technical data. Because U.S. DOE considered the geological-geotechnical suitability a top requirement of a site, a major effort to verify the suitability of the site was made by the ISGS through its many geological and geotechnical studies reported here and previously.

Publication of the results of these studies has been considered essential as a part of the peer review process for technical acceptance and of the state's efforts to demonstrate to DOE the nature, completeness, and accuracy of the data and the suitability of the geology for the SSC

tunnel, chambers, access shafts, and surface facilities. In addition to three earlier published reports, eight published or draft reports were provided either with the state's site proposal or later to RTK and U.S. DOE for their further study and to document information provided in Volume 3 of the site proposal and the Environmental Impact Statement submitted later. These include Environmental Geology Notes 120, 122, 123, 124, and 128.

Public Presentations of the SSC Project *ISGS staff* The SSC project has prompted many requests for public presentations of technical work. Many presentations have required a large team of speakers, staff for displays, and major logistic efforts. Notable among these were the five official Illinois public meetings on the SSC site, the official DOE scoping meeting to provide public input to the SSC siting and environmental issues, and several meetings with CATCH (Citizens Against the Collider Here). In addition, the Survey has provided speakers for civic clubs, professional groups, university classes, service clubs, and various governmental groups. Gross gave 30 such speeches in the last year.

SSC Displays *Hines, Hindman, Gross, and many others* In late FY87 and early FY88, the ISGS produced all of the graphics for the Illinois SSC proposal--work involving extensive communication with IITRI, Harza Engineering, and DENR in Springfield. Then the ISGS produced a large portion of the graphics for the SSC environmental data submission, an even larger task. Hundreds of slides were also produced along with many maps and posters for various public meetings, and our staff designed, with Bally Manufacturing, a major interactive education video display about the SSC. That display, a three-dimensional model with two video screens, is the size of a small car and was used as the focus display for the official DOE site visit to Illinois. It has been in the State of Illinois Center in Chicago, the Illinois Math Science Academy, the Illinois State Fair, the State Capital, and many other locations. Bally appraised the display at $200,000.

Media Tours and Press Inquiries *Gross and others* The SSC project has generated tremendous interest in the newspaper press, radio, and television. In the last year, Gross gave approximately 150 interviews by telephone, participated in a half-dozen press conferences, and participated in a long series of newspaper editorial board interviews. A team of Yonkauski, Lach, Dean, and Gross, in a series of trips averaging one full day in each city, has visited Indianapolis, Columbus, Milwaukee, Chicago, western Chicago suburbs, and St. Louis. Each trip included a luncheon to present the case for the SSC in Illinois, a visit to the editorial board of one of more major newspapers, and various radio and television interviews. Don Perkins (Chairman, SSC for Fermilab), Jim Cronin (Nobel Laureate, University of Chicago), and David Gross visited in New York the offices of The Wall Street Journal, Business Week, and the New York Times. In March, Director Don Etchison and David Gross visited in a two-day period the Chicago Tribune, Chicago Sun Times, Owegawo Sentinel, Naperville Sun, Chronicle Group, Geneva Republican, and others. Then in August, Stan Yonkauski and David Gross repeated that tour.

Special Siting Studies--Argonne Photon Source

Geotechnical Site Investigation, Argonne National Laboratory, Advanced Photon Source *Killey, Trask, and others* This year at the Argonne National Laboratory campus, ISGS geologists worked to verify the presence of predicted geologic materials and to refine the details of their nature and distribution across the proposed site of the $300-million 7GeV Advanced Photon Source (APS) synchrotron. This work was undertaken at Argonne's request to utilize the Survey's database and knowledge, and was also intended to support and supplement the work of their contractor. The effort was viewed as particularly important in providing early information for Argonne's planning purposes, because the services of an architectural-engineering firm had not yet been engaged. Survey geologists provided seismic refraction and electrical resistivity surveys, oversaw drilling and sampling of 28 test holes, analyzed hundreds of samples for standard geotechnical and stratigraphic parameters, conducted downhole geophysical logging at 18 test holes, and monitored water levels in 12 piezometers installed at the APS site. On the basis of the results of these studies, recommendations were made on additional studies (in the areas of settlement, vibration transmission, and hydrogeology) that should be considered by the

architectural-engineering firm to ensure the stable foundations required for this vibration-sensitive facility. Survey geologists will continue monitoring water levels at the site for a full year and will work with the architectural-engineering firm. Results of the study will be presented at the 1988 Annual Meeting of the Association of Engineering Geologists, and a Survey publication is planned.

Argonne National Laboratory Engineering Geology and Geotechnical Study *Su, DuMontelle, Mitchell, and Cremeens* A series of samples from the APS site investigation was tested using standard soil mechanics test procedures. These tests included Proctor compaction tests (both standard and modified), Atterberg limits determinations, specific gravity measurements, and consolidation tests. Test results were used to prepare recommendations for engineering consideration and further investigation.

Environmental Impact Studies

Long-Term Ecological Research (LTER): Environmental Chemistry *Cahill, Steele, and Fisher* The LTER project has provided chemical data needed to evaluate long-term trends in the natural ecosystems of the Mississippi and Illinois Rivers. Chemical analysis of sediment cores and key organisms were made to document perturbations that have occurred in the system. Trace element analyses of 50 freshwater mussel shells have been completed. The levels of barium, iron, magnesium, manganese, strontium, and zinc are significantly different in shells from the two rivers. The use of mussel shells shows promise as an environmental indicator of changes in water chemistry over time. Data sets collected during the project are being incorporated into a combined database for use by researchers at 15 other LTER sites across the country.

Illinois Lands Unsuitable for Mining Program (LUMP) *McKay and Krumm* This multiagency project, funded by the U.S. Office of Survey Mining (OSM), involves several divisions of DENR and the Land Reclamation Division of the Illinois Department of Mines and Minerals (IDMM). The project provides funding to support the DENR LUMP database and its maintenance and development. The database is a significant part of DENR's Geographic Information System. The program with OSM and IDMM also includes a major effort to construct a detailed database for coal mine permit areas.

Mine Permit Review Project (LUMP) *Krumm, Maynor, Pool, Taylor, Graettinger, L. Smith, Kraus, McKay, and T. Johnson* Computer Research and Services Section staff have been using the ARC/INFO Geographic Information System on the Prime 9955 to construct a detailed database for coal mine permit areas in southern Illinois. During the last fiscal year, data have been input for 28 permit areas in Perry County, the leading coal producing county in the state. Geological Survey staff have taken a lead role in this project, coordinating the efforts of several DENR divisions. An on-line query system was developed to track project progress as specific areas are completed.

PSTRAT Well Database (LUMP), *Krumm, Pool, Kraus, Graettinger, Taylor, Maynor, L. Smith, Helm, McKay* A well database on the Prime 9955 has been developed as part of the Mine Permit Review Project. Mine permit applications include drill hole information to characterize both the coal resource and the overburden material. This information has been entered into the PSTRAT database. Additional well logs from the Geological Records Unit have been interpreted and included in the PSTRAT database, which is being developed to be compatible with a similar file used by the ISGS Coal Section.

Impact Studies Technology Transfer and Information Services *CRSS staff* During the past year, Computer Research and Service Section staff have provided hands-on GIS training for IDMM staff involved in the review project on mine permits.

GEOLOGY FOR PLANNING

County Regional Studies

Logan County, Basic Geologic Assessment, *Kempton and Vaiden* Patrick Glithero, Director of the Logan County Regional Planning Commission, contacted the ISGS and State Water Survey about conducting a basic geologic assessment of the county with regard to groundwater availability and groundwater protection. The ISGS and State Water Survey agreed to compile and prepare some preliminary information to assess geologic and hydrogeologic data and compile preliminary maps of the bedrock topography, aquifer thickness and distribution, and a map of surficial deposits to a depth of 50 feet. Glithero also requested cost estimates of a more detailed geology-for-planning study. A draft manuscript and the preliminary maps were completed in late June as a part of preproposal.

Perry County, Coal Mining *Berggren* This project will provide basic geologic information useful to coal mine operators, public officials, and interested citizens planning long-term for coal development in Perry County. Perry County is the leading coal-producing county in Illinois. In 1986, its seven mines produced 13.5 million tons of coal--21.4 percent of the state's total production. Previous studies report that 2,096 million tons of coal reserves remain in the county.

This study, envisaged as the first in a series of similar county reports, will provide geologic information needed for coal mine planning, construction, and operation, for mining regulation, and for other public and private interests.

Kane County, SSC *Curry and Kempton* At the request of Phillip Bus, Director of the Kane County Development Department, the Geological Task Force provided some preliminary geological information to Kane County to help officials update their plan to accommodate the impacts of the SSC construction and operation in the county. The Geological Task Force provided interpretative maps for the SSC project. A proposal was prepared and submitted to the Department of Energy and Natural Resources to facilitate work with the county.

LAKE MICHIGAN COAST AND BASIN STUDIES

Environmental Geochemistry

Lake Michigan: Man's Impact, *Cahill* The chemical analyses of sediments from Lake Michigan serve to document man's impact upon the lake; they can be used to understand the processes that redistribute contaminants in recent sediments. The areas of Lake Michigan where active sedimentation is occurring have been documented by completing the analyses of 283 surface sediment samples for cesium-137 content. Samples were taken according to a grid pattern of the entire lake. A paper to be submitted to the *Journal of Great Lakes Research* will supplement a recently published paper reporting preliminary results for 118 samples.

Chemical Analyses of Sediments and Biological Samples from the Waukegan Harbor Project Area, *Risatti* Our Waukegan Harbor data have been increased by analysis of 11 sediment samples and 30 biological composites (fish, crayfish, and periphyton). Sediments were analyzed for major, minor, and trace elements, total PCBs, organic carbon, phenols, and ammonia. Biological samples were analyzed for total PCBs, lipids, ash, major, minor, and trace elements.

Surprisingly, the PCB levels in the biological composites were primarily in the parts per billion range (2.7 to 1,987 ppb). From previous reports, we expected values in the 10 to 20 ppm range, and our previous analyses of the sediments in the harbor had demonstrated concentrations ranging from 5 to approximately 17,000 ppm. It remains a question whether PCB values are decreasing in Waukegan Harbor fish or whether the fish analyzed had recently moved into the harbor area. PCB levels in sediments collected primarily from the outer harbor area ranged from approximately 13 to 1,700 ppb, and based on station locations and sampling procedures, were within expected values. Analytical work has been completed. Preparation of a final report will

include interpretation of the analytical data and integration of the toxicology data generated by the Illinois Natural History Survey. The U.S. Department of Defense funded the study through the Chicago District of the U.S. Army Corps of Engineers.

Biological, Toxicological, and Bioaccumulation Investigation of Field Conditions at Indiana Harbor and Canal and Adjacent Lake Michigan, *Risatti and Ross (Illinois Natural History Survey)* This research is a joint project to study the effects of contaminants in Indiana Harbor and adjacent Lake Michigan on the indigenous biota. One ISGS task involves analyses of sediment samples and biological composites (fish, crayfish, and periphyton) collected from the study site for total PCBs, total PAHs, major, minor and trace elements, and where applicable, total phenols, cyanide, ammonia, percent lipids, ash, organic carbon, and moisture. We are also conducting experiments to measure rates of PCB and PAH diffusion into organisms by using biological surrogates deployed in the field area.

To date, we have found that PCB concentrations in fish from the Indiana Harbor area are generally greater than those we recently found in fish collected from Waukegan Harbor. Preliminary results also indicate that metal concentrations in the sediments are high for chromium, lead, mercury, and zinc. Although concentrations of contaminants tend to decrease toward the mouth of the harbor, contaminated sediments appear to have been carried into the lake from the harbor. The U.S. Army Corps of Engineers, Chicago District, funded this project.

Coastal Erosion Studies

U.S. Geological Survey/ISGS Southern Lake Michigan Coastal Erosion Program, *Collinson, Chrzastowski, Hansel, Riggs, Terpstra, Lulkin, and Plummer* In 1986, Lake Michigan waters rose to record high levels, subjecting the Illinois shore to devastating damage. In Chicago, devastation of the shore and beaches led the city to plan an $814 million long-term program for rebuilding and development. To provide the technical data necessary for such a comprehensive long-term program, Congress appropriated funds for the U.S. Geological Survey to institute a research program in cooperation with state and local agencies, and $300,000 was passed through to the ISGS in a cooperative program for the calendar year 1988.

In September 1987, the USGS and ISGS undertook pilot bathymetric and sidescan surveys of the Chicago beach between Wilson Avenue and Ohio Street. Two manuscripts and one map with text were completed by March. In spring 1988, the USGS supplied the ISGS with a 21-foot Boston Whaler with navigation and computer equipment for bathymetry and sonar surveying. The USGS research vessel NEECHO visited Illinois during July and August and made geophysical surveys of the Illinois and Indiana shores. It made seismic soundings at 2 to 4 mile spacings out to 10 miles offshore, mapping the thickness of sand, lake clay, glacial till, and the configuration of bedrock.

The ISGS has requested $250,000 for 1989 to conduct additional bathymetry, sediment mapping, and littoral drift studies. As part of the 1988 studies, the ISGS already has produced more than 70 shore maps, a bibliography of several thousand citations, dozens of computer base maps, shore damage lists, and a riparian property inventory.

Framework Studies (Bathymetry and Lake Bottom Morphology)

Chicago Northside Lake-Front Coastal Geology, *Chrzastowski, Shaw, Adams, Hunter, Terpstra, Riggs, and Jennings* From June through November 1987, a detailed hydrographic and geophysical survey was conducted along Chicago's northside lakefront from Ohio Street to Wilson Avenue. This study was in cooperation with the U.S. Geological Survey Branch of Atlantic Marine Geology. Objectives included detailed mapping for studying lake bottom change and identifying potential offshore sand reservoirs for beach replenishment. One map report (to be published by ISGS) concerns nearshore bathymetry, beach shoreline changes and changes to lake bottom profiles between 1976 and 1987.

Chicago Nearshore Bottom Morphology Survey, *Chrzastowski, Riggs, Shaw, Adams, Terpstra, and Hunter* In cooperation with the USGS Branch of Marine Geology, the ISGS completed a detailed hydrographic survey of the nearshore area between Ohio Street and Wilson Avenue. Supported mainly by funds from the Illinois Division of Water Resources, this study produced two reports and a detailed contour map of lake bottom morphology extending 2.5 miles offshore. The map was digitized and is currently stored on computer disks. It has been approved for publication by the USGS. Copies of this map have been mailed to the Chicago Park District, the Army Corps of Engineers, and the USGS at Woods Hole.

Bottom Morphology Survey of Chicago Small-Boat Harbors, *Chrzastowski, Riggs, Terpstra, Adams, and McGovern* In the spring, bottom-morphology mapping was completed for Chicago's eight small-boat harbors: Montrose, Belmont, Diversey, Chicago, Monroe, Burnham, 59th Street, and Jackson Park Inner and Outer Harbors. The data are being compiled and digitized to produce computer maps that will be useful for engineering plans and studies of sediment accumulation, circulation, and fish habitats. The 1-foot contour maps with accompanying text and tables (mean depth, volume, volume/depth ratios) are explected to be completed by early 1989.

Baseline Study of Lake-Bottom Morphology Off North Point Marina, *Chrzastowski, Riggs, Shaw, McGovern, and Terpstra* The newly constructed North Point Marina with its shore-attached breakwaters will influence nearshore sediment transport along the northern Illinois lakeshore. To provide baseline data to compare and monitor lake bottom changes in the short and long term, detailed bathymetric mapping was completed (100-foot line spacing to 2,000 feet offshore) in the marina vicinity from the Illinois-Wisconsin state line to 1.5 miles south. One-foot contour maps and accompanying text are anticipated in winter 1988.

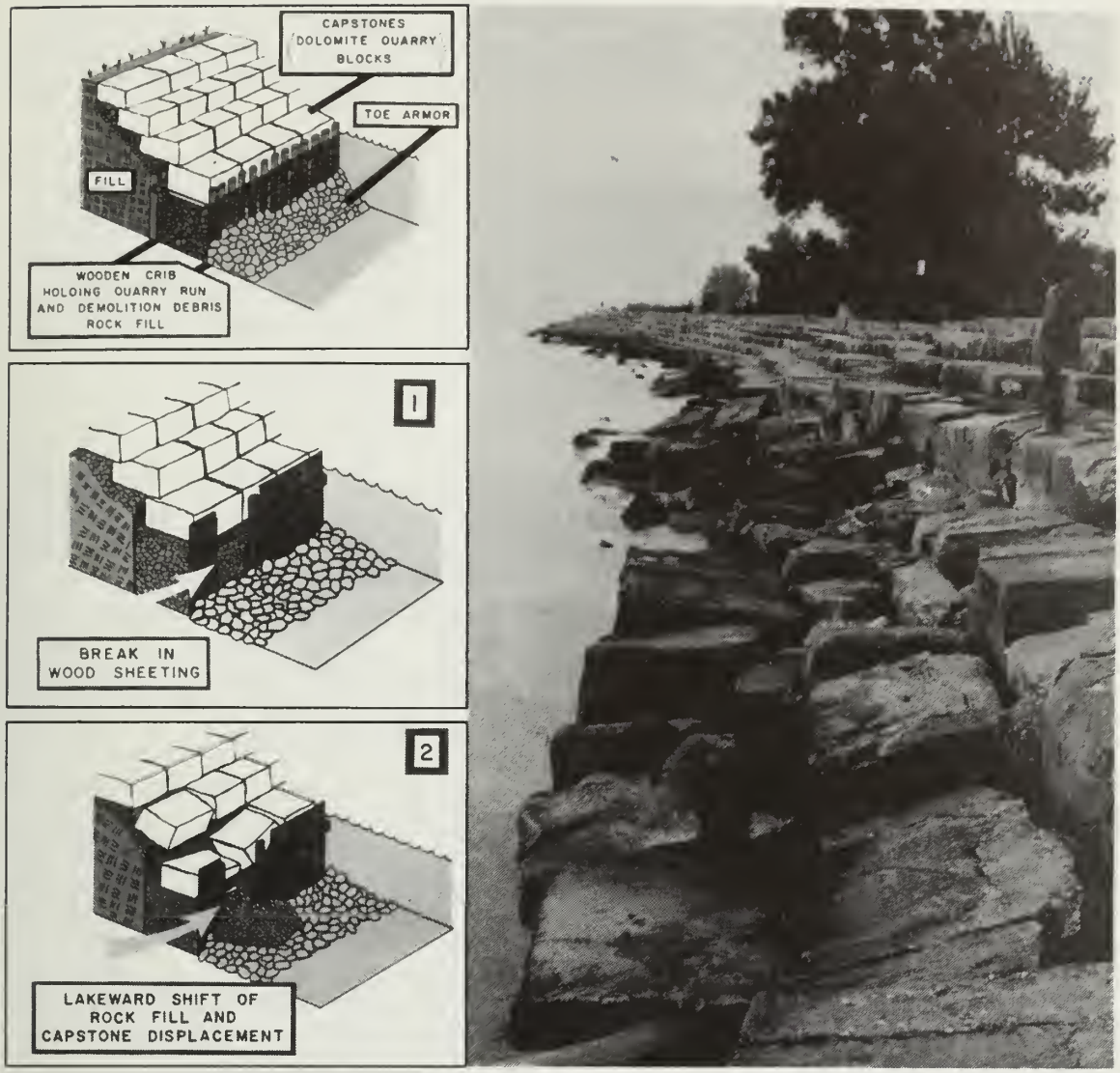
Lake History Studies

Lake Michigan Lake Level and Sedimentation History (LLASH), *Hansel, Chrzastowski, Riggs, and Follmer* This new project is part of the joint USGS-ISGS Southern Lake Michigan Shore Erosion Cooperative Study funded by the USGS. The purpose of this study is to determine how the short (150-year) historic lake level record fits into the long-term geologic record. Emphasis is on establishing the magnitude and timing of lake-level fluctuations that have occurred during the past 4,000 years and postdate the large-scale fluctuations caused by glacial and postglacial uplift events in the basin. A planning session of the LLASH subgroup was held at the USGS National Center in Reston, Virginia, in February and attended by USGS (Reston, Woods Hole, and Menlo Park), ISGS, and IGS (Indiana) scientists. The efforts in Illinois will concentrate on the records preserved in four areas: (1) the Illinois Beach State Park beach-ridge system, (2) alluvial terraces in stream valleys tributary to Lake Michigan, (3) the Chicago outlet, and (4) beaches and spits on the Chicago Lake Plain. Field work began in July 1988. Results of this study have important implications in understanding and planning for both high and low lake extremes.

Lake Chronology in the Lake Michigan Basin and Chicago Outlet Drainage History, *Hansel, and D. M. Mickelson (University of Wisconsin)* The establishment of a radioacrbon chronology of lake level events based on the sediment record in the southern Lake Michigan area has made possible a reevaluation of the timing and causes of high lake phases in the Lake Michigan basin and the Quaternary history of drainage through the Chicago outlet. High lake levels coincide with times when greater amounts of water were coming in to the basin from glacial meltwater, precipitation, and/or drainage changes resulting from differential isostatic rebound in the basin.

Process and Impact Studies

Preliminary Sidescan Sonar Survey of Chicago Lake Front, *Chrzastowski and Schelle (USGS)* Sidescan sonar (100 kHz) furnished by the USGS was used to investigate the underwater condition of the groins, revetments, and bulkheads along Chicago's near northside lake front. This study provides the first definite statement of underwater conditions and processes responsible for widespread structural deterioration. Study findings were published in EGN 128. Higher resolution sonar (500 kHz) will be used to scan the entire Chicago lake front in fall 1988.



Model *(left)* based on sidescan sonar study of damage to Chicago's shoreline protection structures *(right).*

Littoral Drift Budgets for the Illinois Lake Michigan Shore, *Collinson, Chrzastowski, Shaw, and others* In midyear 1987, $25,000 was allotted to the ISGS by the Illinois Division of Water Resources for a long-term cooperative study of littoral drift systems and coarse sediment beach systems. The funds were mainly used to support the pilot bathymetric mapping conducted in fall 1987 in cooperation with the USGS. More than 40 nearshore profiles for measuring littoral drift were acquired during fall 1987.

Nearshore Sediment Gain/Loss Trends for the Illinois Lake Michigan Shore, *Collinson, Terpstra, and Fucciolo* The Illinois Division of Water Resources provided $16,000 for the study of net gains and losses of littoral sediment on the Illinois Lake Michigan shore. The study will consist of computer analyses of available sequential bathymetric maps which are available for several reaches of the shore. The goal is to establish the rate at which littoral sediment is being lost beyond recovery offshore.

Synthesis and Mitigation Studies

Shore Damage and Mitigation Estimates for the Illinois Lake Michigan Shore, *Collinson, Chrzastowski, Shaw, and others* Begun as a small project for the Corps of Engineers in 1986, this effort continued through 1988 to cover both low and high water estimates. The final products of computer files, which describe shore properties, shore protection construction costs, and shore recession maps of Illinois Beach State Park, are still undergoing critical review. An April 1988 version was completed in June.

Database Management

Computerized Shoreline Maps, *Terpstra* More than 200 digital maps produced between August 1987 and July 1988 were stored on computer disks and tape. These maps include Lake Michigan shorelines from various years, onshore cultural features, nearshore bathymetry, landfill areas, parks and harbors, and development of the state's newest harbor, North Point Marina. Each computer map can be plotted at any scale, in whole or in part, and can be combined with other digital maps in various combinations. For example, numerous plots superimpose shorelines from different years to help identify areas where erosion has been most active.

Lake Michigan Shoreline Inventory, *Collinson, Jennings, Plummer, Terpstra, and Lulkin* A revised and updated Lake Michigan shoreline inventory, which gives the status of all properties along the Illinois shoreline, is being prepared. A major part of this work involves revising the 1979 Coastal Atlas. A preliminary draft of the revised atlas, which includes significant information from county and municipal officials, has been completed for the Illinois shoreline north of Lincoln Park, Chicago. Copies of the preliminary draft of the coastal atlas are being distributed to the Illinois Division of Water Resources, Chicago Park District, Highland Park, Lake Forest, Winnetka, and Evanston for municipal use and critical review. Revision of the maps of the southern shore is underway. Plans have been made to incorporate the data on these maps into digital maps, now in the early stages of preparation. Information from the low-level oblique aerial photography program has been invaluable for identifying many very recent shoreline charges.

Photographic Documentation of Lake Michigan Shoreline Changes, *Collinson, Jennings, Plummer, and Terpstra* More than 2,500 low-level oblique aerial photographs were taken during October 1987 and April 1988. In addition, slides were taken from the ground monthly from July 1987 to June 1988. Included among these are 200 photographs of ice conditions taken by Jim Miner of Northern Illinois University, on assignment from the ISGS. Work is progressing on annotating and cataloging the estimated 60,000-slide collection. Used in conjunction with the Coastal Atlas, the slides provide a detailed historical view of the Illinois shoreline. The slides also make it possible to answer questions from the general public and governmental agencies about the stability of specific areas along the shore. Hundreds of slides have been loaned to or duplicated for other agencies, riparian owners, real estate firms, and engineering firms.

Nearshore Lake Michigan Bathymetry Database, *L. Smith, Pool, Gaines, and Helm* Computer Research and Services helped ISGS and USGS staff process and present electronic bathymetric data from the Lake Michigan shoreline in Illinois. Position and depth were measured along preplanned traverses and recorded by computer on magnetic tape. CRSS used these data to produce working maps for the project and contoured the data with ARC/TIN. Lake Michigan project staff were also trained to digitize and plot onshore cultural features. These data are available on the Prime computer Geographic Information System (GIS).

Technology Transfer and Information Services

Chicago Shoreline Protection Commission Shore Study Program and Final Report, *members of the Commission and its staff; Collinson (principal author)* The 26-member commission met bi-weekly from February 1987 through October 1987, while its Executive Committee and the Structural Measures Work Group met on alternate weeks. Collinson was a member of all three and chairman of the Work Group. The Commission devoted itself to shoreline deterioration and damage, mitigation, reconstruction, new developments, and financing.

In February 1988, the Commission published and distributed a 97-page final report that was well received by press and public. Many of its recommendations are already in progress.

Preliminary Protection Options and Alternatives for the Chicago Lakeshore, *Collinson and the Structural Measures Work Group* The Group, sponsored by the Chicago Department of Planning, produced structural protection options for consideration by the Chicago Shoreline Protection Commission. The report was distributed for public comment in November 1987.

Lake Michigan Coastal Erosion Conference, USGS National Center, Reston, Virginia--February 18-19, 1988, *Collinson, Hansel, Chrzastowski, and Riggs* ISGS staff met with USGS staff from Reston, Woods Hole, and Menlo Park and Indiana Geological Survey staff at the USGS National Center in Reston, Viriginia. The Group discussed products of recent cooperative projects, coordinated plans for the summer of 1988, and made financial arrangements. For lake-level studies, it was determined that the USGS will concentrate on lake-bottom seismic records as well as terraces and beach ridges in the northern part of the lake. The ISGS team will study bathymetry, sidescan surveys, and geomorphic and sedimentary records of terraces and alluvial fills in lakeshore valleys along with Illinois Beach State Park beach ridges. The Indiana Survey team will study dune ridges in the Gary and Indiana Dunes area.

Development and Planning: Lake Michigan Shoreline Landfill--Loyola University of Chicago, *Collinson* Collinson is chairman of the Peer Review Committee for Development and Planning of the Loyola Landfill project, which proposes an 18-acre projection into the lake at the lake-front campus in the Rogers Park District of Chicago. Because the project has broad public attention, the planning program is extensive and sophisticated, involving a dozen national and international authorities on coastal development. Extensive wave-tank tests are being made at the Canadian National Research Council Hydraulic Facility in Ottawa. Collinson has witnessed several sets of tests there and produced two review reports concerning them. Two additional reports will be required along with several conferences and two public meetings. ISGS has provided maps, photos, new bathymetry, and critical review reports. ISGS bathymetry of the area will be measured in October.

Rosewood Park (Highland Park) Shoreline Improvements and Recreational Development, *Collinson* The Highland Park District is planning an ambitious recreational shore park development. ISGS has supplied bathymetry, historical map, and photos. Collinson is a member of the Peer Review Committee.

Bibliography Initiative for Lake Geology (BILG)--Part of USGS-ISGS Cooperative Project, *Holm and Morgan* In this project, a computerized bibliography of Lake Michigan publications was compiled. Approximately 2,000 articles covering Lake Michigan research on geological and physical processes from 1960-1986 have been entered into the database. Computerized searches of GEOREF, a database of geological publications, and other water resources information databases have been in progress to cover publications from 1860-1960 and 1987-June 1988. Completion of the bibliography on geological research and physical processes is planned for the winter of 1988. In addition, a bibliography covering all Lake Michigan research publications from 1960-1986 will be published in late 1988. This will include publications on biology, chemistry, geology, and physical processes.

Negotiations are underway with Chris Pollini (in charge of the USGS bibliographic effort) to convert ISGS bibliographic files to the INMAGIC (database management program) software mode, and transfer them to USGS. USGS also would like to have the ISGS state-of-the-art bibliographic system with consultant and tutorial assistance. Those add-on services are being negotiated.

Great Lakes Lake Trout Research Inventory, *Holm and Morgan* This project consisted of listing all current research projects (1985-present) on lake trout being conducted on the Great Lakes. The inventory will enable the Great Lakes Fishery Commission to better define and coordinate its research and management efforts on lake trout. The Commission distributed the

final report, containing descriptions of 200 projects, to fishery managers and researchers throughout the Great Lakes Basin.

Rivers and Backwater Lakes

Lower Cache River: Environmental Geochemistry, *Cahill* The lower Cache River represents a unique wetland in southern Illinois. Agricultural drainage and diversion projects threaten the existence of the associated wetlands. Cesium-137 dating of a sediment core from the Lower Cache River Wetlands has shown the technique to be reliable in determining recent sedimentation rates in the area. Nine additional cores are now being dated in cooperation with the Illinois State Water Survey to determine the sedimentation patterns in the wetland area to help in conservation efforts.

Lake Peoria: Environmental Geochemistry, *Cahill* The rate of sediment accumulation in Lake Peoria is severe. Dating of Lake Peoria sediment samples by Cesium-137 determinations was found to yield accurate calculations for the rates of sedimentation in the lake when compared to volumetric measurements conducted by the Illinois State Water Survey. A joint manuscript describing the technique is in preparation. Chemical analyses of sediment cores indicated changes in the environmental quality of the lake over the last 30 years. The impact of dredged Peoria lake sediments on water quality was reviewed in a preproposal sent in response to IDENR's Environmental Research Program. Responses were made to inquiries from the staff of State Senator Hawkinson concerning the impact of Lake Peoria dredge spoil on the immediate area of spoil disposal.

Peoria Lake Investigation, *Grubb, M. Miller* The deltas invading Lake Peoria constitute a significant volume of the sediments rapidly filling in the lake, and this study is working out their history, forms, and the factors that control them. Aerial reconnaissance and photography provided an overview of the system and photographic base maps for mapping. The dynamic and dramatic yearly changes in delta formation and evolution necessitate these aerial surveys.

Approximately 75 stratigraphic sections were exposed by trenching and measured during this time; two deltas associated with Blalock and Partridge Creeks were topographically mapped. Preliminary analysis of the sedimentological and morphological data suggest that the deltas are dominated by braided river and hyperconcentrated flow hydraulic regimes. Significant reworking of delta fronts by wind- and towboat-generated waves was also documented in the form of four beach ridges on delta margins. Vegetation is a significant control on delta morphology. Plants stabilize the land forms and preclude subsequent modification by either fluvial or lacustrine processes. Additionally, dead vegetation forms dams in the creeks, causing avulsion of the fluvial system and the construction of new delta lobes.

Future research on these deltas will include additional stratigraphic and geomorphic analysis of as many as six additional deltas and associated drainage basins in the Lake Peoria region and quantification of basinal sediment yield and energy balances within the fluvial/lacustrine system. Funds from the final year of LTER funding supported this past summer's work.

A Six-Month Study of the Geology and Hydrology of the Des Plaines River Wetlands Demonstration Site, *M. Miller, Holden, and Berg* This study monitored changes in channel morphology and groundwater elevations over an 18-month period ending in December 1988. Earlier surveys delineated erosion and deposition areas within the channel in the project area. These studies will be compared to refine and check the pattern of deposition and erosion in the wetlands area. During the fall of 1987, a 100-year flood event occurred in the project area and the surveys before the flood will be compared with those after the flood to delineate channel changes.

The existing groundwater observation well network was augmented by 13 additional nests containing 13 observation wells for water table elevations and 36 piezometer wells to determine groundwater flow directions. Water levels were recorded monthly and indicate that groundwater

movements into and out of the river channel change seasonally. The river channel in the north half of the site shows groundwater recharge during the spring and discharge during the summer and early fall. In the southern half of the project area, groundwater discharges continuously to the river bed with seasonal changes in intensity.

One-Year Geomorphic and Hydrologic Characterization of the Des Plaines River Wetland Demonstration Site, *Holden, M. Miller, Berg, Pool, and Hensel* Twenty-eight cross-section profiles were established along a 4.3 km reach of the Des Plaines River. These profiles were measured in June and November 1986 to establish and characterize the river geomorphic characteristics before construction of a wetland demonstration site by Wetland, Inc. The original plans were to compare pre- and post-construction surveys of the river character to determine whether the construction had altered river morphology or process. Construction delays have postponed the completion of the project, but the two measurement periods show that the river has a complicated pattern of erosion and deposition that did not show measurable change between June and November of 1987.

Thirteen groundwater piezometer nests were monitored monthly between June and December 1987. The data show, as predicted, a water table that mimics surface morphology with groundwater movement from valley sides to the river channel and down valley.

Adsorption of Cu, Zn and Pb by Alluvial Soils and Floodplain Sediments--Wetlands Demonstration Project, *Holden* An investigation is underway to determine how soils and sediments in a wetlands site on the Des Plaines River attenuate and desorb copper, zinc, and lead from solution. Concentrations of these metals (inorganic pollutants) in lakes and rivers frequently exceed water-quality criteria. Sediments were sampled at two constructed wetland ponds, a natural swamp, a constructed backwater slough, several vegetated and unvegetated backwater areas, and two floodplain terraces. The samples were characterized physically and chemically. Adsorption-desorption experiments were conducted by equilibrating varying concentrations of Cu, Zn, and Pb chloride solutions with the <<2-mm portion of the samples.

All three metals were readily adsorbed, particularly by the materials with high organic carbon contents and large clay-sized (<<2-mm) fractions. Ion exchange on negatively-charged soil minerals is the process by which adsorption and desorption of positively-charged ions is thought to take place. In most of the experiments, however, the metal ions were not desorbed from the soils back into solution, indicating that attenuation mechanisms other than ion exchange may be dominant in these systems. Precipitation of the metals, which would tend to keep them out of solution, has been ruled out in most of these cases using geochemical modelling. The metals may also be irreversibly held (complexed) by organic matter and oxide minerals within the soils. The presence of oxides has not yet been determined, but a group of samples has been ashed to remove the organic matter. Additional experiments using these samples are underway to determine the effects of the elimination of organics on amounts of adsorption (expected to be lower) and desorption (expected to be higher).

HYDROGEOLOGICAL INVESTIGATIONS

Groundwater Resources

Groundwater Resource Assessment in Northern Illinois, *R. Gilkeson, McFadden, Gendron, Stanke, Morse, Orozco, Cheryl Wegscheid, and Holden* Supported with aquifer assessment funds from the Illinois Department of Energy and Natural Resources, this new program involves a rigorous review of our statewide database for groundwater resources. The program is a 3-year investigation in the northern 35 counties of Illinois--the region in which approximately 100 public water supplies exceed the U.S. EPA drinking water standards for radium and barium. The high concentrations occur naturally in deep bedrock aquifers. The primary task is to gather information about shallow groundwater resources that have very low dissolved concentrations of radium and barium.

The first 2 years of the program are concentrated in the northeastern counties, where information on shallow groundwater resources is also needed because of regional development. County governments are being invited to participate in the program by providing county records and personnel to verify the location of well records. Du Page, Kane, Lake, and McHenry Counties are participating in the effort. A statistical study of the accuracy of well locations submitted by drillers determined that the locations are highly inaccurate and that an ongoing well-location verification program is essential when drillers' records are used as geologic information for regional groundwater resources assessments.

Groundwater Resources in Kane County, *R. Gilkeson, Laymon, McFadden, Holden, and Wegscheid* This thorough study of groundwater resources in the glacial drift and shallow dolomite bedrock of Kane County is supported by funds from the county and local municipalities and from the Division of Water Resources of the Illinois Department of Transportation. The regional program's successful identification of aquifers with large potential groundwater supplies has encouraged several communities to make separate contracts with the Illinois State Geological and Water Surveys to evaluate the methods and assess groundwater resources. Contracting communities include Aurora, Batavia, Geneva, Montgomery, and St. Charles. These contracts are significant because they involve the design of sophisticated aquifer tests to evaluate regional productivity of the shallow aquifers. So far aquifer tests have been performed at Aurora, Geneva, and Montgomery. Additional tests are being designed for these three communities and also for the communities of Batavia, St. Charles, Elburn, and Hampshire. Surface geophysical methods are playing an invaluable role in the design of these tests and in the overall assessment of the regional groundwater resource.

Geophysical Study of Shallow Groundwater Geology in Kankakee and Northern Iroquois Counties, Illinois, *McFadden, Morse, Orozco, E. Smith, and Wegscheid* Farmers in eastern Kankakee and northern Iroquois Counties are pumping great and increasing amounts of groundwater for irrigation. This use is causing seasonally declining water levels in the shallow dolomite bedrock aquifer and local problems with some wells. Plainly needed is a better understanding of the shallow hydrogeology of the area, particularly the long-term effects of continued large withdrawals.

This study revised hydrogeologic mapping in a particularly complex area using geophysical methods. Seismic refraction was used to map the bedrock surface. Electrical earth resistivity surveys and borehole geophysical surveys were used to supplement information from existing well records on the nature of the glacial drift.

Assessment of Regional Groundwater Resources in Kankakee and Northern Iroquois Counties, *McKenna, E. Smith, and Dey* As part of a study by the Illinois State Water Survey to assess the groundwater resources of the two-county region, ISGS staff produced six maps and five cross sections depicting the areal geology. This information was used to select monitoring well locations and sites for geophysical evaluation methods.

Mapping Shallow Aquifers in the Danville Vicinity, *McFadden, Morse, P. Reed, Kempton, and Vaiden* In the vicinity of the city of Danville (Vermilion County), shallow aquifer mapping and test drilling have resulted in one successful shallow well with a potential yield of about 1,000,000 gallons per day. The Inter-State Water Company, which supplies water to the city, is interested in developing shallow groundwater resources to augment its present water supply. Other potential areas for shallow groundwater development, based on the hydrogeological mapping, have been identified, and the final report is in preparation.

Water Use Act Activities, *Hensel, McKenna, E. Smith, J. Gilkeson, and Mushrush* Under the provisions of the Water Use Act of 1983, the ISGS and ISWS provide technical assistance to the staffs of County Soil and Water Conservation Districts who assess the potential impacts of large-capacity water wells on groundwater resources. During this period, Survey staff evaluated 35 well sites to determine the hydrogeologic conditions present in the area of these wells.

Service Geophysics--Electrical Earth Resistivity Surveys, *P. Reed* Electrical earth resistivity surveys are conducted on the land surface and are relatively quick and economical means to locate the sand and gravel aquifers buried in deposits. This year surveys were made at 58 sites in 29 Illinois counties. These included 43 farm and acreage sites, 1 irrigation site, 3 public supply sites, and 11 municipalities (Camargo, Chenoa, Danville, East Peoria, Edinburg, Ellsworth, Indianola, Island Lake, Lostant, Newton, and Round Lake). Work was also performed for the Illinois Department of Public Health to define a pollution problem at a subdivision. Phil Reed has compiled a map showing counties in which EER (electical earth resistivity) and geophysical borehole surveys were made in FY88.

Groundwater Protection

Mapping of Underground Sources of Drinking Water, *Seaber, Krause, Waldeck, Poole, Helm, and Hwang* This new project began in May 1988 and is funded by the Illinois Department of Mines and Minerals. The investigation will determine the distributions of groundwaters in Illinois with estimated total dissolved solids concentrations of less than 3,000 mg/l, between 3,000 and 10,000 mg/l, and greater than 10,000 mg/l. The project will develop a database that the Department of Mines and Minerals can use in their analysis of Class II well permits. The program planning and existing data and water sample collection have begun and data are being entered into the database. Clay County is the pilot study area for the remainder of the state. A data report for that county will be completed in August 1988.

USDW Database, *Kraus, Denharat, and Helm* As part of the project on mapping dissolved solids in groundwater, conducted with the Illinois Department of Mines and Minerals, the Groundwater and Computer Sections have automated groundwater-quality information from 350 wells in Clay County on the Prime 9955.

Appropriate Recharge Area Mapping of Illinois, *Berg, McKenna, Keefer, E. Smith, Hensel, Dey, and Cartwright* The Illinois Groundwater Protection Act requires the ISGS and ISWS to map and prioritize the state's groundwater recharge areas and aquifers in order to direct detailed local studies on hydrogeology and protection strategies. To map recharge areas according to their sensitivity to contamination, we are updating the state stack-unit map and producing a slope map of the state. A method for evaluating relative degrees of recharge in different geologic terraces currently is being formulated. At the same time we are examining and updating additional prioritization criteria that eventually will be coordinated with the geologic-slope information. These data include waste generator sources, population distribution and public and private well location. All of this information will be used to guide the selection of areas in Illinois for detailed geologic mapping and groundwater investigation.

Environmental Effects of Oil Field Brines, *Hensel* A reconnaissance study, funded by the Illinois Department of Energy and Natural Resources to assess the effects of past and present oil brine disposal practices on the water, soil, and biotic resources of southeastern Clay County, has been completed and the project report is being reviewed.

Electrical earth resistivity, a geophysical technique was used to map the brine plumes emanating from two filled-in brine holding ponds. This method works well because the highly saline, brine-contaminated water has lower electrical resistance than fresh water. Groundwater around these filled-in holding ponds was found to be contaminated by brines.

The study analyzed groundwater samples from domestic water supply wells in southeastern Clay County and discovered no evidence of regional brine contamination. However, naturally occurring saline water was found in some relatively deep water wells. Chemical analyses that measure ion ratios and salinity of the samples are used to differentiate oil-well brine from shallow brine and freshwater sources.

As a final task, estimates have been made on the potential impacts of brines in other oil producing counties in Illinois. Shallow aquifers in these areas are most susceptible to oil brine

contamination because water quality may be affected by seepage from overlying brine ponds, potential leakage from brine injection wells, and/or upward migration through possible unsealed boreholes.

Assessment of Effects on Groundwater of Contaminant Migration Through Typical Geological Sequences of Illinois, *Hensel, Griffin, and Berg* This completed research quantitatively ranks the potential for groundwater contamination that land burial of municipal waste may cause in several mapped hydrogeologic settings common in Illinois. It also determined that a proposal by the Illinois Pollution Control Board (IPCB) for a groundwater compliance distance of 100 feet is appropriate as a regulatory criteria of maximum leachate migration from municipal landfills. A draft report has been sent to the two sponsoring agencies.

Assessment of the Occurrence of Agricultural Chemicals in Groundwater in Mason County, *McKenna, J. Chou, Valkenburg, Mushrush, Dey, and Gilkeson* Preliminary results from this recently completed project indicate that the upper portion of the Mason County aquifer has been significantly contaminated by nitrogen fertilizers. Nitrate-nitrogen levels exceeded the drinking water standard (10 mg/L) in 58 percent of the samples from the monitoring wells (10 to 30 feet deep) and 49 percent of the samples from private wells (25 to 40 feet deep).

Traces levels of pesticides are reaching shallow groundwater; however, pesticide concentrations exceeded the drinking water standards in only a few samples. Analyses of 15 samples from irrigation wells 75 to 120 feet deep indicate that the lower part of the aquifer is still relatively unaffected by pesticides and nitrates. Although the overall frequency of detection of agricultural chemicals in the shallow monitoring and private wells was high, there was extreme variability over time in the occurrence of agricultural chemicals in any particular well.

Pilot Study of a Field-Scale Model to Evaluate Pesticide Movement to Groundwater, *Bicki (Department of Agronomy, University of Illinois), McKenna, Dey, and Berg* The goal of this study, funded by the U.S. Department of Agriculture Pesticide Impact Assessment Program, is to develop a methodology for evaluating the potential for pesticide contamination of shallow groundwater in individual farm fields. Results of computer modeling with the U.S. EPA Pesticide Root Zone Model (PRZM) will be combined with detailed hydrogeologic data developed during the geology-for-planning study for Boone and Winnebago Counties, completed by the ISGS in 1982.

Agricultural Chemicals in Rural Private Wells: Recommendations for a Statewide Survey, *McKenna, Mehnert, Mravik, Mushrush, Keefer, and Dey* This recently completed Geological Survey/Water Survey project designed a statistically valid survey of the occurrence of pesticides and nitrates in rural private water supply wells. The plan recommends procedures for selecting wells to sample, for selecting the analytes, and for collecting and analyzing the samples.

Persistence and Mobility of Selected Pesticides in Loessial Soils of Illinois, *Bicki (Department of Agronomy, University of Illinois), McKenna, J. Chou, Valkenburg, Dey, Moore, Warren, Mushrush, Miller, and Roy* This study will improve our ability to predict how several widely used agricultural pesticides move and lodge in fine-grained soils. Samples were collected from soil cores and pressure-vacuum lysimeters located at depths of 1, 2, and 3 meters in four soils planted in corn/soybean rotation. Pesticide analyses have been completed for more than 300 soil samples. Preliminary results indicate only limited transport of pesticides below 60 cm.

The results of the soil and water analyses will be used to evaluate a pesticide transport model developed by the U.S. EPA. The relationship between soil properties and pesticide movement will also be evaluated.

Pesticide Mandate--Groundwater Protection Act, *McKenna, Mehnert, Dey, Smith, Keefer, and State Water Survey* The objective of the pesticide mandate are to (1) determine the general location and extent of any pesticide contamination of groundwater, (2) assess patterns of pesticide usage and potential for contamination in Illinois, and (3) evaluate agricultural chemical practices

for potential to contaminate groundwater, and (4) make recommendations to minimize their effects. To date, efforts have focused on developing the design for a statistically valid survey of agricultural chemicals in rural domestic water wells (partly supported by Illinois Department of Energy and Natural Resources Aquifer Assessment Funds) and compilation of primary data.

Evaluation of Discharge from Drainage Tiles for Characterizing Pesticide Migration into Groundwater, *Keefer and McKenna* Pesticide levels in soil water samples, drainage tile discharge, and shallow groundwater monitoring well samples are being measured to evaluate the movement of pesticides in a tile-drained field. This study is funded by the Water Resources Center and is being completed with Dr. Thomas Bicki of the Agronomy Department at the University of Illinois.

Potential Impact of Waste Generation and Disposal Practices on Shallow Groundwater Resources, *Keefer, Greenpool, and Berg* The statewide stack-unit maps are being automated to create maps that better evaluate the potential impact of waste generation and disposal practices on the quality of shallow groundwater resources. The project is supported by the Hazardous Waste Research and Information Center (HWRIC). Four geologic risk conditions were identified: aquifers at the land surface, aquifers within 20 feet of the surface, aquifers between 20 and 50 feet below the surface, and no aquifers within 50 feet of the surface. This information currently is being combined with HWRIC data that describes protected lands, waste disposal sites and waste storage, generator, and transport facilities. The final maps will identify parts of the state where more detailed investigations are warranted.

Hydrogeologic Processes

Hydrogeology of the Maquoketa, Galena and Platteville Groups in the SSC Site Area, *Schumacher, Curry, Graese, and Vaiden* This study is utilizing hydrogeologic data collected during pressure (packer) tests of SSC boreholes, water levels obtained in these boreholes, and recent results of regional studies of groundwater in northern Illinois to determine the geologic controls on vertical and horizontal permeability. These data will be integrated to calculate more precisely the vertical rates of groundwater movement. This study, conducted in collaboration with the State Water Survey, should provide an assessment of the amount of groundwater leakage that occurs through the Maquoketa and into the underlying units and aquifers.

Technology Transfer and Information Services

Preliminary Groundwater Quality Assessment of a Selected Area in St. Clair and Madison Counties, Illinois, *McKenna, E. Smith, J. Gilkeson* Survey staff evaluated the geologic materials comprising the valley fill of a portion of the American Bottoms for an ISWS assessment of groundwater quality in the area. A preliminary stack-unit map of materials to a depth of 20 feet and several cross sections were prepared to help the ISWS locate sites for groundwater sampling.

Location of Gassy Aquifers in Illinois, *Riley* In the 1960s, a field study was initiated to investigate the occurrence of natural gas in fresh water wells in Illinois. Approximately 1,400 tests were conducted on water wells in virtually every county, and information about well location and construction, natural gas analysis, and the approximate quantity of gas in the water were collected. These data are being entered, on a time available basis, into a computer data base with the ultimate goal of producing a map showing the locations of excessively gassy aquifers in the state. This information will be of interest to well drillers and well owners because some of the well gases are explosive. To date, all of the analyses of natural gas in water and natural gas from water well flow tests from two counties have been entered into the data base.

Interpretation of Geothermal Surveys to Detect Aquifers, *Larson* Geothermal prospecting for groundwater, a method which utilizes small variations in ground temperature to locate shallow aquifers, was conceived by ISGS scientists in the 1960s. A new, computerized interpretation method for this prospecting tool is now being developed to make it more practical. Simple one-

dimensional models have demonstrated that the theory is correct. A more realistic, two-dimensional model is now being tested.

Service Requests for Groundwater and Geologic Information, *section staff* Requests for information comes from citizens, well drillers, industries, farmers, and governmental agencies, desiring to locate, develop, use, evaluate, or protect potable groundwater resources. Inquirers most frequently ask for information to determine the potential for obtaining an adequate well supply. Many seek background geologic information for sites with landuse practices that could potentially compromise the quality of shallow groundwater. Responses to inquiries during fiscal year 1988 have been handled by phone (1,250), letter reports and technical letters (325), and directly to visitors (90). Sites in nearly all counties in the state (except Pope, Mercer, and Warren) have been involved with the service activities during this fiscal year 1988.

WASTE MANAGEMENT

Hazardous Wastes

Hydrogeological and Hydrochemical Assessment of the Basal Paleozoic Units for Wastewater Injection and Confinement in Illinois, *Brower, Keefer, Gendron, Stecyk, Poole, and Seaber* This study is part of a regional project funded by the Underground Injection Control Practices Council and the U.S. EPA to assess the hydrogeology and hydrochemistry of the Mt. Simon Sandstone and its overlying confining units. A significant number of disposal wells inject hazardous wastes into this unit, a suitable repository for this type of waste disposal over most of the southern two-thirds of the state.

Geochemical Interactions of Liquid Hazardous Wastes with Geological Formations in Deep-Well Systems, *Roy, Mravik, Krapac, Dickerson, and Griffin* The U.S. EPA and the Hazardous Waste Research and Information Center supported a study of the geochemical interactions of hazardous wastes with rock formations that are used for deep-well injection disposal. Geochemical interactions of two liquid wastes were investigated in the laboratory using disaggregated core samples of the Mt. Simon Sandstone and the Potosi Dolomite, representing



Jeff Brown (Velsicol Chemical Corporation) and Susan Mravik (ISGS Geochemistry Section) sample hazardous waste stream for a laboratory study.

the two major types of materials used for injection, and the Proviso Siltstone, representing a confining-bed materials. The waste-interaction studies were conducted in batch reactors under low-oxygen conditions and were heated and pressurized to simulate subsurface conditions corresponding to three depths of injection. An inorganic acidic waste was neutralized when reacted with the three formation samples via carbonate dissolution with the concomitant generation of dissolved carbonates and carbon dioxide. An alkaline, brine-like waste was rendered nonhazardous (by pH criterion) at the highest temperature and pressure studied. It was concluded that fate modeling based on thermodynamic principles can quantitatively predict some types of geochemical interactions, but that empirical investigations may be needed to complement an assessment of the fate of injected wastes. This study also suggested that the injection of these wastes pose few environmental problems.

Investigation of the Hydraulic Effects of Deep-Well Injection of Industrial Wastes, *Gendron, Brower, and Mehnert* A numerical modeling study was conducted to evaluate the effects that the injection of the industrial waste in an operating disposal well had upon the rock receiving the waste. The well is an operating Class I injection well in Clark County. Data required for model input were obtained from ISGS and company records and from geophysical logging, coring, and hydraulic testing.

Modeling results indicate that pressures resulting from injection at IEPA permitted rates will be less than the pressure needed to initiate hydraulic fracturing and should not jeopardize human health and the environment. However, during the study the mineral, brucite, was observed to form within the primary injection zones. The extent and rate by which brucite formation is reducing the injection zone's permeability is not known and requires investigation.

Evaluation of Underground Injection of Industrial Waste in Illinois, *Brower, Hensel, Krapac, and the State Water Survey* The final report of this study (which was mandated by the Environmental Protection Act, January 1985) was revised from the final draft report entitled *Evaluation of Current Underground Injection of Industrial Waste in Illinois*, HWRIC Report of Research No. 008, 1986. This final report is scheduled for publication in fiscal year 1989 as Illinois Scientific Surveys Joint Report 3. It reviews the regulations, permitting practices, disposal operations, fate of injected wastes, and disposal alternatives associated with disposal in Class I disposal wells in Illinois. It also draws conclusions about the adequacy of the regulatory program and the appropriateness of this method of disposal for hazardous and nonhazardous industrial wastes in Illinois.

Sampling Protocol Development for Volatile Organic Pollutants in Fine-Grained Material, *J. Chou, Herzog, Valkenburg, and Griffin* The purpose of this study was to develop a sampling protocol for volatile organic pollutants in the subsurface at the Wilsonville hazardous waste disposal site. In earlier studies, removal of 4 to 6 well volumes of stagnant water prior to collection of samples for inorganic analysis has been recommended. However, this method is not practical for wells with very low recharge rates; most wells at the Wilsonville site could be pumped down to the top of the well screen after removing less than 2 well volumes. Thus, the question arises as to what impact the well recovery time has on the volatile organic pollutants of the water sample collected for analysis.

Eleven wells were sampled before purging and at times of up to 48 hours after purging. Samples were collected with dedicated point-source Teflon bailers equipped with bottom-emptying devices that were designed for collecting samples for chemical analysis of volatile organics. All wells could be evacuated with a bailer and all had hydraulic conductivities of between $5x10^{-7}$ and $3x10^{-5}$ cm/sec. Although samples collected after purging had slightly higher concentrations of volatile organics than samples collected before purging, statistical analysis showed that there was no significant difference (at the 95-percent confidence level) between samples collected from 2 to 48 hours after purging.

Groundwater Monitoring and Modeling with Biodegradation of Organic Pollutants at Wilsonville Waste Disposal Site, *J. Chou, Herzog, Peach, Valkenburg, and Griffin* This project evaluated the effectiveness of the clean-up at the Wilsonville hazardous waste disposal site and described and simulated the process of contaminant transport in the subsurface. Because the geology of Wilsonville is analogous to other areas in Illinois, this modeling approach may be useful at other sites in the state.

Historical data indicate a natural decrease of contamination near the trench as the chemicals disperse and move down gradient. Increased volatile organic chemical concentrations are now being seen farther from the trench area. It is too early to see the effects of the waste exhumation on chemical concentrations in samples taken from monitor wells. In the modeling study, the USGS Method of Characteristics (MOC) Model was used for depicting groundwater flow. The analytical data collected this year from wells in a contaminant plume and hydraulic conductivity values determined from recovery tests in those wells will be used with previous data to describe and simulate the process of contaminant transport. The study of biodegradation of selected organic contaminants in the subsurface materials by indigenous microorganisms is also under evaluation.

Geologic and Hydrologic Factors for Siting Hazardous and Low-Level Radioactive Waste Disposal Facilities, *Berg* The ISGS and the ISWS have produced a document that outlines the process and tasks required to locate and characterize hazardous and low-level radioactive waste disposal facilities. The siting process is divided into three main steps--regional screening, site screening and site characterization. Numerous geologic and hydrologic criteria are discussed in association with each step. This document is the first report of its kind to deal with such data in a comprehensive format. It will help state and local officials understand the complexities of geology and hydrology in the siting process. More importantly, it will give siting contractors a checklist of factors that must be considered and understood to construct and maintain an environmentally safe facility.

Clay and Hazardous Wastes, *Hughes and Warren* Because clay minerals act as barriers and absorbents for most types of hazardous wastes, research continues to locate clay-rich strata for waste disposal. This work supports development of methods to clean up or seal existing waste sites, and techniques to use special clays for the safe storage of wastes in new sites. Recent laboratory effort has been focused on analysis of data associated with the Wilsonville site and on further development of the concept of using hydrophobic clays in the storage and clean up of wastes.

Low-Level Radioactive Wastes

Low-Level Radioactive Waste-Disposal Site Screening Maps, *L. Smith, Krumm, Pool, Maynor, Graettinger, Taylor, and McKay* Under a contractual agreement with Battelle Memorial Institute in Columbus, Ohio, the Computer Research and Services Section used the Geographic Information system on the Prime 9955 to digitize and compile statewide (1:500,000) and county-level (1:250,000) data. This will aid regional screening of exclusionary and favorability factors to assist in locating potential sites for the low-level radioactive waste-disposal facility. Automated statewide factors included seismic risk, structural features, oil and gas resources, and economically minable coal. At the county level, areas of potential subsidence, relative drift permeability, distribution of sand and gravel and of shallow aquifers were compiled. As a result of this effort, significant data have been contributed to the GIS, several potential sites were selected, and a site-specific study began.

Coal Wastes

Geochemistry of Aggregate Flotation Process By-Products, *Dreher, Roy, Rostam-Abadi, Demir, Rapp, Mravik, Steele, and R. L. Berger (Department of Civil Engineering, University of Illinois)* The overall objective of this research is to recommend environmentally acceptable methods to dispose of or re-use the waste solid from the ISGS Aggregate Flotation process and

thereby aid in developing the process. This first year of research we have sought to simulate disposal of the waste solid below the water table by using laboratory aqueous batch extraction tests. In these tests, waste solid was mixed with water and allowed to stand, with periodic mixing, for up to 180 days. At the end of the test, the water was analyzed to determine which elements were leached from the solid and to what degree, and what mineralogical changes may occur. Another aspect is to study strength development in the ultrafine waste after mixing with hydrated lime and curing the mixture in a 100-percent carbon dioxide atmosphere, or after mixing the waste with Portland cement, with or without admixed coal fly ash.

Results have shown that various elements are leached from the waste solid by water, and in increasing amounts with longer contact times. Some mineralogic changes occurred. The net results of these effects indicated that disposal of the waste below the water table without further treatment could increase the dissolved solids content of the associated groundwater. Mineralogic changes will probably result in volume changes over time. The volume changes may affect the mechanical stability of the waste deposit. Mixing of the waste solid with hydrated lime or cement imparts significant strength to the material and may also decrease the degree to which inorganic constituents are leached from the solid.

Database Management

Statewide Landfill Inventory Update, *Mushrush and Mehnert* The Statewide Landfill Inventory was updated with data obtained from IEPA and the Northeastern Illinois Planning Commission. Mapping locations were recalculated. Requests for information were filled from this database.

Underground Injection Control (UIC) Class I Database, *Evans, and Brower* Monitoring data submitted by the seven Class I deep-well disposal facilities in Illinois are entered into the UIC database using R-Base System 5. Entered data include well operational parameters, chemical analyses of waste streams, and listing of correspondence. Lotus 123 and Symphony worksheets have been prepared to provide ready transfer of monthly reported monitoring data from each of the seven disposal sites to the database via modem or floppy diskette. These worksheets also allow easy, initial review capabilities through use of graphs and tagging of noncompliance parameters. Programs are being developed to further analyze these data and display the results on appropriate graphs and tables. This computerized database and programs have been developed for the Division of Land Pollution Control at the IEPA. This is a component of the work done under the Service Agreement of the UIC Class I Program.

Class II Well Database, *Denhart, McKay, Kraus, and Graettinger* This project to integrate the Illinois Department of Mines and Minerals database of Class II injection wells with the ISGS Basic Well Data File on the Prime 9955 has been completed. The DMM files contain such data as the number of cement sacks used in the casing of each well, the depth at which the well was plugged, and the packer depth in feet. The ISGS files contain such information as the location and owner of the well, the history of the well from the initail permit issuance, and the current status of the well based on documents received from the owners. Combining the two databases permits both agencies to access all the data and produce a verified inventory of brine injection and disposal wells in the state--the first inventory of these 13,524 wells. Well location maps have been plotted for several heavily drilled counties in the southeastern part of the state, providing a valuable tool for assessing the impact of brine injection and disposal on potable groundwater supplies in southern Illinois.

Technology Transfer and Information

Technical Assistance to McLean County in the Siting of a Regional Pollution Control Facility, *Herzog* Survey staff provided advice and counsel to the McLean County Board at hearings on a proposed landfill, gave a presentation to the Board on the hydrogeological aspects of landfills, and advised county staff at the hearings as requested.

Service Work Related to Landfilling of Solid Waste, *Groundwater Section staff* Twelve preliminary hydrogeologic evaluations were prepared for proposed waste disposal sites in seven counties. More than 50 letters in response to questions relating to landfills were sent; 5 of these related to specific sites. More than 75 requests for information were handled on the phone, and 17 visitors came to discuss waste disposal issues. A preliminary hydrogeologic evaluation was prepared for a chemical spill in LaSalle County.

Addressing the Economic Impact of Proposed Pollution Control Board Regulations, *Keefer, Greenpool, and Berg* A service/research contract from the Illinois Pollution Control Board has supported a Survey mapping investigation that enables the Board to evaluate the potential economic impacts of their newly proposed municipal landfilling regulations. Using the GIS, staff mapped and tabulated areas geologically sensitive to landfilling by re-evaluating the automated stack-unit map of the state in terms of each unit's potential for contamination. It was found that highly sensitive areas where aquifers are within 50 feet of the surface occupy 43 percent of the state. Protected lands were also evaluated. These include floodplains, wetlands, and designated state and federal owned land and comprise about 12 percent of the state.

Technical Support to IDNS for LLW Siting, *Berg, Curry, and Tierney* The ISGS in cooperation with the Illinois State Water Survey is providing technical support to the Illinois Department of Nuclear Safety (IDNS) in its efforts to site and characterize a low-level radioactive waste (LLW) disposal facility in Illinois. The ISGS has compiled information about the regional geologic frameworks of the candidate sites in Clark and Wayne Counties. Site exposures, samples, and cores have been studied. Survey scientists are also serving on a Technical Advisory Committee chaired by IDNS. The group advises both IDNS and siting contractors on geologic, hydrologic, and environmental issues. The Survey has also reviewed and commented on the adequacy of site characterization plans and activities and assisted in the collection of data. The Survey is required to comment on the licensability of candidate sites.

Underground Injection Control Class I Service Program, *Brower, Evans, Mehnert, Gendron, and Illinois State Water Survey* Geological Survey and Water Survey staff continue to provide technical consultation to the IEPA in its Underground Injection Control Class I program. This regulatory program covers 11 disposal wells at seven industrial sites in the state. A lengthy period of review and well testing procedures for permits and well closures is nearing completion. A new regulatory program known as Land Ban Petitioning for disposal of hazardous wastes will require detailed review of petition documents and also some testing of wells. One petition is currently under review. A computerized database for monitoring data obtained from the disposal wells has been developed and programs are being developed to analyze these data. Survey staff have responded to about 30 inquiries concerning this method of disposal.

EARTH HAZARDS AND GEOTECHNICAL STUDIES

Radon

Radon Investigations, *Cahill* There is a national concern for the impact on public health from indoor concentrations of radioactive radon gas. In Illinois, the significant sources of radon to indoor environments are naturally occurring geologic materials. The major source of radon in buildings is the entry of soil-air containing radon from geologic materials in the immediate vicinity of the buildings. Homes that have private water wells may also receive amounts of radon from groundwater as it enters the dwelling. Several geologic factors must be evaluated to accurately determine the "radon availability potential" of geologic material in Illinois.

The success of any geologic investigation regarding radon depends on the ability to obtain accurate and reliable analytical data. The equipment and procedures necessary to measure radon in air with grab samples and integrated measurements (4-day exposure with charcoal canisters) have been established. The procedures were recently verified by successful participation in Round 5 of the U.S. EPA's National Radon Measurement Proficiency Program.

Procedures for the analysis of radon in water were applied to the testing of 250 water samples from 41 wells located in different regions of Illinois. The radon concentrations are low and vary between 80 and 1,690 pCi/L. These levels are below a suggested drinking water standard of 10,000 pCi/L. A program to determine the concentrations of radon in Illinois groundwater samples and the impact of dissolved gases on the release of radon into homes is being developed.

Landslides

Landslide Study at Chester, Randolph County, *Su and Stohr* Investigation of the landslides at Chester included soil tests, topographic surveys, and seismic surveys conducted at five selected sites. Historical aerial photographs of the city were studied to find evidence of ancient and modern landslide activity and about 30 landslide episodes were identified. Direct shear tests on soil samples and slope stability analysis of each site are currently being made. A water leakage problem at the Chester High School also is being investigated to determine whether the water seeps and standing water observed at the high school track and field stadium are caused by groundwater or a water main broken by landsliding. Results of chemical analysis of the water samples for fluorine and chlorine indicate the source of the water may be a break in the city water line.

Landslide in Iroquois County, *Killey, Bradford, and Krumm* Compilation of 17 months of monitoring data, in combination with laboratory and engineering data from drilling and sampling, have resulted in a coherent theory explaining the current cycle of instability in this creek-bank slump threatening a township road in Iroquois County. A paper presenting conclusions of the study was presented at the environmental geology session of the North-Central Section of the Geological Society of America this spring, and a first draft of a Survey publication on the study has been completed.

Illinois Mine Subsidence Research Program (IMSRP)

The Illinois Mine Subsidence Research Program was established in 1985 to develop guidelines for underground mining methods that would maximize coal extraction while preserving the productivity of prime farmland in Illinois. The program was initiated at the request of the Illinois Coal Association and the Illinois Farm Bureau and is directed by the Illinois State Geological Survey.

Illinois Mine Subsidence Research Program (IMSRP), *DuMontelle, Bauer, Gefell, Barkley, Trent, Brutcher, Van Roosendahl, and Danner* In July 1987, presentations were made to the ICA/IFB Mine Subsidence Committee and the ICA Technical Committee to allow their members to review and comment on the progress of the IMSRP. An annual summary report covering all the projects and an annual detailed report on the overburden instrumentation was submitted by ISGS to the Illinois Coal Development Board. In October, presentations were made to the IMSRP Advisory Board to review proposals and plans for 1988-1989. A Program Assessment Report and Program Implementation Plan for IMSRP activities for 1988-1989 were submitted in January and approved by the Illinois Coal Development Board in March 1988. Funding for the 1988-1989 fiscal year was set at approximately $445,000.

Robert Darmody of the Agronomy Department, University of Illinois, has completed work on the third year's measurement of crop yields over high-extraction coal mines in Illinois. Paul Chugh of Southern Illinois University has completed work on the investigation of floor stability in two mines for the last fiscal year, making a total of five mines completed for the program. James Mahar and Michael J. Hasek of the University of Illinois collected and prepared samples to determine the strength of Illinois coal and the effect of sample size and shape on strength. Instrumentation was monitored by ISGS personnel during planned subsidence over a high-extraction retreat mine in Williamson County.

Five publications concerning project reports and a subsidence bibliography and on the IMSRP computerized database were reviewed, edited, and published during 1987-1988. IMSRP now has permission from two new mining companies to instrument longwall mining panels to document the



Brenda Mehnert and Dan Van Roosendaal, members of the ISGS team working on the Illinois Mine Subsidence Research Program, monitor overburden response at an active longwall mining site.

overburden response to subsidence. IMSRP is currently conducting drilling and instrumentation of two longwall mining panels. Dr. Colin Booth, hydrologist from Northern Illinois University, is directing studies to investigate the efforts of subsidence on an aquifer above the panels.

Time Domain Reflectometry, *Barkley, Bauer, and Brutcher* Investigators continue to develop a simple way to monitor subsidence movements in bedrock. Coaxial cables were grouted into boreholes over a subsiding high-extraction retreat mining panel and monitored as subsidence occurred. The cable broke at the interfaces of materials with contrasting strengths, e.g. at the drift-bedrock contact and the base of a thick fragipan in the upper 10 feet of glacial drift. A second site is to be instrumented over a longwall panel near Rend Lake. As with the earlier studies, Dr. Charles Dowding and Kevin O'Connor of Northwestern University will assist with Time-Domain Reflectometry investigations.

Evaluation of Exposure of Population and Urban Development to Potential Subsidence from Underground Mines, *C. Treworgy, Baxter, Hindman, and Pan* Work began on a contract from the Illinois Mine Subsidence Insurance Fund to evaluate the coincidence of mined-out areas with urban lands and high population density. Task 1 of the contract involves compiling and digitizing maps of mined-out areas of non-coal underground mines (limestone, clay, tripoli, lead, zinc). In Task 2, these data will be combined with the Survey's computer database of coal mines and merged with data on urban landcover and population density. Tables and maps will identify areas where population and urban buildup have the greatest exposure to potential mine subsidence. The results of this study will be used by the Mine Subsidence Insurance Fund to evaluate risk of damage from mine subsidence throughout the state.

Computer-Assisted Directory of Mine Subsidence Insurance Claims, *Hindman, Schwartz, Junkins, and DuMontelle* The Illinois Mine Subsidence Insurance Fund (IMSIF) renewed support for the database until June 1989. This year fields were consolidated and shortened, new programs were written for data entry and printing, and forms for investigators to use in the field were completed. The database is now more efficient and easier to use.

More than 60 maps, showing densities of claims overmined areas for 18 counties, were created with the GIS and sent to IMSIF to fulfill contract obligations.

A subsidence risk map for lead and zinc mines in Jo Daviess County was created for the IMSIF. This project demonstrated that non-coal mines are possible sources of mine subsidence hazards, and that the GIS can be used to determine how much urban land is undermined and potentially threatened by subsidence. This pilot project led to the funding of another in the Coal Section for a state-wide study of the relationship between all underground mines, urban areas and population.

Determination of True Orientation for Tiltmeters and Its Application to Trench Cover Movement, *Su* As a part of the Wilsonville study, data from tiltmeter surveys were interpreted and displayed for final reports. A computer program to determine the true orientation of tiltplates was modified from a mainframe version to a microcomputer version. The program is now available for use for data from many other projects where tiltmeters are installed to monitor such things as trench covers, subsidence events, and landslides.

Rock Mechanics and Geotechnical Support Studies

Engineering Geology Studies, *Su, DuMontelle, Mendoza, and Cremeens* Standard soil mechanics tests were completed on 15 bag samples collected from the full-scale earthen liner during its construction. The tests included standard Proctor compaction tests, Atterberg limits determinations, specific gravity measurements, and pin-hole tests.

Microcomputer-Based Data Acquisition System, *Su and Hasek* Both hardware and software for rock uniaxial compressive tests have been designed and built. The hardware includes a portable microcomputer, five sets of DC-LVDTs (Direct Current Linear Variable Displacement Transformer), electronic circuit boards for power supply and data Input/Output, and circuit boards for amplifying input signals. The software is a user-friendly menu-driven program developed using ASYST Forth Programming Language. The system is able to collect 16 different input signal at a sampling rate of 100 readings per second. The testing results are simultaneously displayed on a monitor as either tables or figure graphics. At the end of test, the test results are saved on diskettes in LOTUS 123 file format. The hardware and software packages, while developed primarily for the rock mechanics investigation related to siting the Superconducting Super Collider, may be used for any number of geotechnical investigations requiring measurements of rock strength.

Technology Transfer and Information Services

Northeastern Illinois Office of the ISGS, *Dixon and Adams* The Survey maintains an office at the State of Illinois Center in Chicago to provide technical liaison with government and industry and furnish geologic information to the general public. The office contains a reading library holding ISGS publications, selected documents, and maps pertaining to northeastern Illinois. The two satellite image maps published by the ISGS are sold there. The facility is used by members of the public and government agencies and firms involved in geotechnical engineering, waste disposal, drilling, and mineral development. The staff provides geologic information and reviews geologic portions of project studies. The staff also collects boring logs, photographs, reports, rock cores, soil samples, and other kinds of data from local firms. The office also provides technical support to the SSC Project Office in Batavia and liaison with SSC for Fermilab, Inc.

To acquaint potential users with the office, which was just opened last year, an explanatory letter and recipient-needs questionnaire were sent to more than 800 organizations (state, local, and private). The responses to the questionnaire (approximately 25 percent) provided useful feedback on the types of information needed by the different groups which had been targeted (municipalities, public libraries, geotechnical firms, mineral industries, and rock clubs). The greatest interest expressed was for topographic maps, and the maps for northeastern Illinois will be included in the over-the-counter sales program. Before receiving the letter, many organizations were unaware of the ISGS presence in northeastern Illinois. Since the mailing,

letters, telephone calls, and visitors have increased 61 percent, and technical calls have increased 85 percent. As a result of the survey, the Northeastern Illinois office has a firm idea of the needs and interests of the technical and general public.

Mine Subsidence Information Dissemination, *DuMontelle and IMSRP staff* The National Symposium of Mining, Hydrology, Sedimentology, and Reclamation was held in Springfield on December 7-9, 1987. During the symposium, a one-day session on mine subsidence was held, chaired by DuMontelle, ISGS, and Ron Caudle from SIU-C. IMSRP researchers, including Bauer, Barkley, and Gefell, presented papers. ISGS prepared a display booth to exhibit and distribute IMSRP information at the symposium. The booth featured a working demonstration of the use of Time Domain Reflectometry equipment to measure movement in the overburden.

An Industry Briefing of the Illinois Mine Subsidence Research Program (IMSRP) was held August 16 in Mt. Vernon, Illinois. Members of the Illinois Coal Association and the Illinois Farm Bureau served as moderators. Participants were provided with information materials describing the progress of different parts of the IMSRP.

General and Basic Research

GENERAL AND BASIC RESEARCH

CRUSTAL STUDIES

Deep Seismic Data

Proposal to COCORP for North-South Spur, *Heigold and Eidel* A proposal to the Consortium for Continental Reflection Profiling (COCORP) was delivered to Cornell University, Ithaca, New York for a deep seismic reflection traverse extending in a north-south direction across the transition zone between the Reelfoot Rift and the Rough Creek Graben of the New Madrid Rift Complex. The traverse would connect completed east-west COCORP traverses across Illinois-Indiana and Tennessee-Arkansas. The proposed traverse has been placed on COCORP's agenda. This seismic traverse will provide an image of the deepest portion of the Illinois Basin across the area proposed as the location for the Illinois Basin Ultradeep Drillhole (IBUD).

East-West COCORP Seismic Line Across Illinois Basin, *Heigold* The Consortium for Continental Reflection Profiling (COCORP) has completed an EW transect extending from the Ste. Francois Mountains of Missouri to eastern Ohio. The most dramatic result from the survey is the delineation of widespread layered rocks beneath the Illinois Basin of southern Illinois and Indiana. These strata are several times thicker than the overlying Phanerozoic sediments. Their precise age and composition are yet to be determined. They are believed to be Proterozoic--greater than 570 million years old. If they are in part sedimentary rocks, they could have hydrocarbon potential. This discovery is relevant to understanding the evolution of the Illinois Basin.

The ISGS provided counsel and advice to COCORP in the acquisition and interpretation of this line and also assisted John Sexton of SIU in related efforts to obtain experimental data in southern Illinois using the same energy source as that employed by COCORP.

National Seismic Network--Northern Illinois Station, *Heigold* Input to National Seismic Network Program (USGS and NRC) was given at St. Louis University, St. Louis, Missouri regarding the location of a seismic station in northern Illinois. The USGS/NRC program began in 1987 with installation of central processing system in Denver, Colorado area. Deployment of seismic stations will be completed in 1992. The ISGS will continue to provide the geologic information required to select this site.

Earthquake Epicenters Map, *Krumm and Gaines* The Prime 9955 GIS earthquake database was used to develop a basemap of earthquake epicenters and intensities, showing all epicenters in Illinois for quakes of Modified Mercalli Intensity III or greater.

Global Geoscience Transects

North-South and East-West Crustal Transects of Illinois, *Heigold* Paul Heigold attended the second U.S. Conference on Global Geoscience Transects (GGT) in Reston, Virginia. The ISGS contribution to the GGT project will consist of east-west and north-south transects that will in turn include the COCORP completed (E-W) and planned (N-S) transects across the Illinois Basin. The transects or cross sections will also be based on oil and gas drilling data to 15,000 feet and the gravity and magnetic maps of Illinois.

Scientific Drilling

Illinois Basin Ultradeep Drillhole, *Leighton, Eidel, and ISGS Staff* Because of the lack of National Science Foundation (NSF) funding, the U.S. Scientific Drilling Program, including ultradeep drilling (greater than 20,000 feet), has not progressed significantly. The U.S. Continental Scientific Drilling and Exploration Act that requests the NSF, the U.S. Department of Energy, and the U.S. Geological Survey to present Congress with a unified U.S. continental scientific drilling plan has passed both houses. In anticipation, the Interagency Coordinating Group (ICG) composed of the three agencies, is convening a working group of 33 scientists to advise them in constructing a unified scientific plan. Jim Eidel has been requested to attend as a member of that group.

In the interim, the Illinois Basin Ultradeep Drillhole (IBUD) has been included in the NSF/Deep Observation and Sampling of the Earth's Continental Crust (DOSECC), Inc. 1989-1991 Program Plan as one of ten deep or ultradeep drilling projects under consideration. Eight of the ten projects, including the IBUD, are listed as pending. If significant funding of DOSECC and the Continental Scientific Drilling Program proves likely, a revised proposal will be submitted.

Three papers on the IBUD were delivered during the year to the Interstate Compact Oil Commission (Leighton), Kentucky Oil and Gas Association (Eidel), and North American Conference on Tectonic Control of Ore Deposits (Eidel). These papers were also submitted to DOSECC, which recognized the contribution as further development of the original IBUD proposal.

Borehole Logging

Nuclear and Non-nuclear Borehole Logs, *DeMaris, Morse, and other staff* Nuclear and non-nuclear borehole geophysical studies have been made at 99 sites in 15 Illinois counties this year. The logs recorded at these sites are useful in aquifer and stratigraphic evaluation, and in determining the physical characteristics of consolidated and unconsolidated earth materials.

BASIN ANALYSIS

Framework Studies

Illinois Basin Cross Section Project, *J. Treworgy, Whitaker, Sroka, Pool, L. Smith* A grid of 20 regional cross sections covering the Illinois Basin, including adjacent areas of Indiana and Kentucky, was selected on the basis of available deep wells, relation to structural features and depositional trends, and proximity to major oil fields. The purpose of this cross section network is to provide a better picture of the stratigraphic, structural, and paleoenvironmental framework of the entire Paleozoic section of the Illinois Basin. This improved picture will significantly enhance the effectiveness of hydrocarbon and other mineral exploration in the basin.

These cross sections will be constructed using wireline logs. Logs for the first four cross sections have been digitized and are being correlated.

Structural Geology and Tectonic History

Structural Features of Illinois--An Encyclopedia, *Nelson* This major work (344 pages and 68 figures plus a statewide map at a scale of 1:500,000) describes every known fault, fold, and other structural geologic feature partly or wholly within the state. The manuscript is in review.

Burial History Studies

Episodic Potassic Diagenesis of Ordovician Tuffs in the Mississippi Valley, *Kolata with R. L. Hay and J. Matthews (University of Illinois), M. Lee (Mobil Oil), and J. Morton (Case Western Reserve University)* Cambrian-Ordovician strata of the Mississippi Valley have been extensively modified by potassic diagenesis. Ordovician vitric tuffs are altered to K-feldspar and mixed-layer illite-smectite (I/S); both have been dated K/Ar. Age data document three Paleozoic episodes of potassic diagenesis, which have mean ages of 396 Ma (Early Devonian) for K-feldspar of the Upper Mississippi Valley (UMV), 362 Ma (Late Devonian) for I/S of the UMV, and 265 Ma (Permian) for I/S of Missouri. These three episodes are apparently due to periods of major regional flow of basinal brines caused by groundwater recharge on uplifted arches. This research could provide insight to the timing of major periods of hydrodynamic flow and possible impacts on hydrocarbon migration and entrapment. Results were published in *Geology*, August 1988.

Stratigraphy

Cross Section of the Sauk Sequence--Phase I, *Sargent* Phase I will be a detailed corrollary to the general cross-section program now underway. Rocks of the Sauk Sequence (top of Precambrian crystalline basement to the base of the Middle Ordovician; 525 Ma to 470 Ma) will be correlated and illustrated on cross sections that combine information from geophysical borehole

logs, lithologic sample studies, and reflection seismic profiling into an integrated geological interpretation. These sections should be especially useful to the petroleum and minerals industries. Although data from this ancient part of the geological record are sparse, this integrated approach will help to show probable source rocks, possible migration paths, and potential plays for petroleum exploration. In addition, facies changes that are known to be associated with mineral deposits elsewhere in the Midcontinent will be highlighted.

***Sea-Level Changes in the Ordovician Champlainian and Cincinnatian Series of Illinois and Iowa**, B. Witzke (Iowa Geological Survey) and Kolata* Relative changes in sea level can be interpreted for any given stratigraphic sequence at specific localities, but the problem remains as to whether these changes are due to local and/or regional structural influences or to fluctuations in global sea level. Only through broad-scale regional, interregional, and intercontinental correlations and stratigraphic analyses can the eustatic overprint be interpreted with confidence and an accurate picture be developed of the depositional and erosional history of a given area.

Thickness and lithofacies patterns as well as general stratigraphic relations were examined in the Ordovician Champlainian and Cincinnatian rocks of Illinois and Iowa. Stratigraphic analysis indicates relatively rapid subsidence of the craton in and adjacent to the New Madrid Rift Complex during Blackriveran (mid-Champlainian) time followed by relatively uniform subsidence across the northern Midcontinent beginning in Rocklandian time and continuing to the end of the Ordovician. The Ozark Dome and Transcontinental and Wisconsin Arches were uplifted during Champlainian and Cincinnatian time. Shallowing and deepening depositional trends seen in the Iowa-Illinois area record bathymetric changes in the Midcontinent seaways that may be of eustatic origin. Three large-scale transgressive-regressive episodes can be recognized in ascending order: the St. Peter-Platteville, Galena (Trenton), and Maquoketa cycles. Smaller-scale transgressive-regressive subcycles can be recognized within these larger cycles. These cycles correlate across large areas of North America and may ultimately prove useful for defining event stratigraphy of continental or global scale.

***Correlation of Ordovician K-Bentonite Beds in Eastern North America**, Kolata, J. Frost and Huff* Two Ordovician K-bentonite beds (altered volcanic ash) have been correlated on the basis of chemical fingerprinting, wireline logs, and outcrop studies from the Mississippi Valley region eastward into the Appalachians from Birmingham, Alabama, to Maritime Canada. The same beds have been correlated into the Michigan Basin and southern Ontario, Canada. These beds cover an area of approximately 500,000 square miles of eastern North America and represent extremely useful time lines that provide a previously unattainable level of accuracy in Ordovician chronostratigraphy.

Analysis of certain trace elements indicates that the parent magma, from which the ash was derived, was calcalkaline in composition, varying from trachyandesite to rhyolite. In addition, the K-bentonites contain rare earth element compositions that indicate that the tectonic setting of the volcanoes ranged from syn-collision plate margin to back arc basin. This study was funded by the National Science Foundation.

***Silurian Lithostratigraphy and Biostratigraphy of Northeastern Illinois**, Mikulic and Norby* The lithostratigraphy and biostratigraphy of the Silurian rocks of northeastern Illinois is being studied. The goal is to establish a reference section which will aid in developing aggregate resources of northern Illinois along with oil and gas resources in southern Illinois. Work has started in Kankakee County and several quarry sections have been measured. Caves in Kankakee, Will, and Cook Counties have been examined during the past year.

***Biostratigraphic Zonation of Lower Devonian of the Illinois Basin**, Devera* Two sections were measured (325 feet thickness), and each bed was sampled. This project on the biostratigraphy of the Lower Devonian will be Mr. Devera's Ph.D. thesis. Field work (sampling) is conducted under the COGEOMAP geologic mapping program in southern Illinois.

Tri-State Committee on Correlations in the Pennsylvanian System of the Illinois Basin and Cooperation on Basinwide Projects, *Jacobson, Nelson and Damberger* A major meeting of this committee was held in Henderson, Kentucky, to work on agreements for standardizing formational nomenclature. Several names have been recommended for common adoption but further work will be necessary before these recommendations can be accepted.

A first joint basinwide project on the geology and coal resources of the Springfield Coal was agreed upon. This is one of the major coals of economic importance in the Basin. Work on the compilation of data available on the computers of the three Surveys was begun which will culminate in a number of basinwide maps depicting the geology of this important coal seam.

Stratigraphic Correlations of the Seelyville, DeKoven, and Davis Coals in Illinois, Indiana, and Kentucky, *Jacobson* Circular 539 was published during this report period. The study demonstrates that the Dekoven and Davis Coals of the southern part of the basin are actually splits of the Seelyville Coal which has been mapped in the east-central part of the basin.

Fluvial-Deltaic Deposits of Early Pennsylvanian Age Exposed Along the Pounds Escarpment, Southern Illinois, *Jacobson* This paper was published in the Geological Society of America's Decade of North American Geology (DNAG) Guidebook No. 3, North-Central Section. The guidebook describes the 100 most significant outcrops in the North-Central Region of the GSA; these guidebooks should serve many potential users in academia, industry, and government. The outcrop described in this paper is one of the best exposures of the basal fluvial-deltaic strata of the Caseyville Formation in the state.

Lithology, Geochronology, and Elemental Analyses of Gulfian (Upper Cretaceous and Paleocene Deposits in Illinois, *Reed, Masters, Glass and J. Frost* Sedimentological characteristics at the Cretaceous-Tertiary (K-T) boundary are still under study at two exposures in the northernmost part of the Mississippi Embayment near the Ohio River in Pulaski County, Illinois. Comparison of trace elements from this part of southern Illinois has indicated relationships with the K-T boundary in the Mississippi Embayment, Gulf Coastal Plain, and other parts of the world. Knowledge gained from this project continues to be shared with the Louisville District of the U.S. Army Corps of Engineers who are interpreting the character of the Embayment Sediments in the vicinity of the proposed Ohio River dam at Olmsted in Pulaski County.

Paleoenvironmental Studies

Middle Devonian Paleogeography, *Devera and Fraunfelter* A presentation on the Middle Devonian paleogeography and tectonics in the southern portion of the Illinois Basin was given at the International Symposium on the Devonian System held in Calgary, Alberta, Canada in August 1987, and a paper has been submitted for publication in the symposium volume.

Illinois Basin--A Tidally and Tectonically Influenced Ramp During the Mid-Chesterian, *J. Treworgy* The purpose of this study of mid-Chesterian units was to characterize the depositional setting of these rocks throughout the Illinois Basin and then extrapolate these findings, as appropriate, to the rest of the Chesterian, which is similar in character. The Chesterian is the most significant hydrocarbon-producing series in the basin, and an understanding of facies relations is critical to finding more oil.

Interpretation of the lateral and vertical lithofacies distribution of the siliciclastic Fraileys/Big Clifty and carbonate Haney Formations indicates that the Illinois Basin was a low-angle, low-relief ramp that was tectonically and tidally influenced during mid-Chesterian time. The southern end of the present-day Illinois Basin was a shallow, subaqueous sill that separated the Illinois Basin ramp from the epicontinental sea to the south. Three changes in relative sea level that affected sedimentation and the early diagenetic history of the sediments were documented. This work was published in the ISGS Circular series this year.

Synthesis

Illinois Basin Region, Chapter 14 in The Geology of North America, Vol. D-2, Sedimentary Cover--North American Craton, Geological Society of America, *Collinson, Sargent, and Jennings* This illustrated summary of the Illinois Basin history has been printed as author's copies. It probably will be offered for sale at the GSA meeting in Denver. The report presents much previously unpublished information and represents a major step toward developing a more modern history of the region. New areas for investigation have become obvious. Among them are the roles of surrounding arches, especially the Kankakee, the Mississippi River (Northeastern Missouri Arch of some authors) and the broad divide between the Kankakee and the Cincinnati Arch. Even more intriguing is the history and basement configuration of the Reelfoot Rift--Pascola Arch area.

AAPG Interior Cratonic Sag Basin Volume, *Leighton, Eidel, Kolata, Oltz, and others* The ISGS staff, working with geoscientists from the Indiana and Kentucky Geological Surveys as well as from academia and industry, are compiling one of five volumes to be published in the American Association of Petroleum Geologists' (AAPG) World Petroleum Basin Series. This series will present a broad overview of fundamental basin types, basin evolution, oil and gas plays, and distribution and size of oil and gas fields. Compilation of this volume is providing important insights into the geology, geophysics, and geochemistry of the Illinois Basin. Knowledge gained will help guide future investigations of the mineral resources in Illinois.

During this reporting period all in-house and external manuscripts were completed, at least to the first draft stage. Most were sent out for peer review and returned to the authors for final revision. The volume represents a major task; it will contain more than 600 pages and 360 illustrations and become a standard geological reference on the Illinois Basin with chapters on and comparisons with similar basins around the world.

Chesterian Geology and Structural Framework of the Illinois Basin, *J. Treworgy* Five short papers were written on various aspects of the Chesterian geology and structural framework of the Illinois Basin for the join publication of the Illinois and Indiana-Kentucky Geological Societies, Geology and Petroleum Production of the Illinois Basin.

GEOLOGIC AND TOPOGRAPHIC MAPPING AND REMOTE SENSING

Geologic Mapping

Cooperative Geologic Mapping Program with the U.S. Geological Survey (COGEOMAP) *Damberger, Danner, DeMaris, Devera, Jacobson, Nelson, Peppers, Trask, Weibel and others* The fourth year of cooperation with the U.S. Geological Survey (USGS) to geologically map fifteen 7.5-minute quadrangles along the southern closure of the Illinois Basin runs to mid-November 1988. A proposal for extension to a fifth year has been submitted.

The main target of the mapping is the lower Pennsylvanian coal-bearing sequence, which has never been mapped in detail even though it crops out in a wide east-west belt across southern Illinois. Work was completed as follows:

- ***Geologic Map of the Creal Springs Quadrangle,*** *Trask and Jacobson* During the report period, all reviews and revisions of this map were completed. The final draft was sent to Northern Illinois University Cartographic Laboratory to produce color negatives from which the printing plates will be made.

- ***Geologic Map of the Goreville Quadrangle,*** *Jacobson, Damberger* All field mapping on this quadrangle was completed, and the first draft submitted for peer review. In-house review by other COGEOMAP participants was completed and the revised map sent to our coordinator at the USGS for his review. During the period, two holes were drilled to obtain a complete stratigraphic section of the basal Spoon Formation and all of the Abbott Formation for this quadrangle.

• ***Geologic Map of the Makanda Quadrangle***, *Jacobson, Weibel, Damberger* Field work on this quadrangle has started with preliminary reconnaissance of the exposures of Chester (Upper Mississippian) strata.

• ***Geologic Map of the Bloomfield Quadrangle***, *Nelson* Geologic mapping of this quadrangle was completed. As it is not part of the agreement with the USGS, publication will not be pursued for the present.

• ***Geologic Map of the Lick Creek Quadrangle***, *Nelson, Weibel* Field work on this quadrangle has been nearly completed.

• ***Geologic Maps of the Eddyville and Stonefort Quadrangles***, *Nelson* The two quadrangles have been readied for final drafting and for preparation of the color negatives by the Northern Illinois University Cartographic Laboratory.

• ***Geologic Map of the Glendale Quadrangle***, *Devera* Field mapping was completed and a draft of this map was compiled and submitted for internal review.

• ***Geologic Map of the Wolf Lake Quadrangle***, *Devera* Mapping has been well advanced; completion is expected for this fall.

• ***Geologic Map of Waltersburg Quadrangle***, *Weibel* The geologic map and accompanying cross section were compiled for review.

• ***Report on the Bedrock Geology of the Creal Springs, Eddyville, and Stonefort Quadrangles***, *Nelson, Jacobson, Trask, Devera* The first draft of a Survey circular to accompany these three quadrangles was compiled and a first round of reviews--including one by C. Rice of the USGS--was completed. Modifications in response to the reviewers' comments were underway by the end of the reporting period.

• ***Report on the Bedrock Geology of the Goreville Quadrangle***, *Jacobson* A manuscript describing the geology of the Goreville Quadrangle has been drafted and should be ready for review early this fall.

• ***Report on the Bedrock Geology of the Glendale Quadrangle***, *Devera* The detailed geologic report on this quadrangle has been partially completed, and review will start this fall.

• ***Diamond Core Drill Program***, *Damberger, Jacobson, Nelson, Weibel, Danner, DeMaris* Two, five-hole drill programs were completed--one early, the other late in the reporting period. These drill holes are important supplements to the geologic mapping. They provide firm stratigraphic control, fill gaps left by lack of bedrock exposures, and provide samples of rock and coal for analyses, both for stratigraphic purposes and to determine the quality of coal seams. Depth of the drill holes ranged from 100 to 300 feet. Two holes were drilled on each of these quadrangles: Waltersburg, Stonefort, Glendale, Lick Creek, Goreville.

• ***Palynological Correlations for COGEOMAP***, *Peppers* During the report period, about 20 coal samples were submitted by the field geologists for palynologic identification and correlation.

Remote Sensing

Remote Sensing Reconnaissance of Reclaimed Oil-Brine Pond Sites in Clay County, Illinois, *Stohr and Smith* Survey staff used a helicopter-borne thermal infrared (TIR) scanner to conduct a remote sensing study of groundwater flow and temperature patterns associated with reclaimed oil-brine pond sites. The winter reconnaissance was conducted after sundown in order to maximize the temperature difference between the relatively warmer groundwater and the relatively colder soil, vegetation, and surface water. Groundwater flow discharge into streams and gullies was easily detected with this method.

An anomalous "hot spot" on a drainage divide was detected where surface water is usually frozen by low overnight temperatures (5-day average overnight low temperature was 28.2°F). The cause of the restricted "hot spot" is unknown.

Thermal infrared imagery has been used in other states to detect springs (and sometimes caves), brine pits, gas flares, and may be useful for finding abandoned or poorly plugged wells.

West Central Illinois SLAR Experiment, *Stohr, Gefell, DuMontelle, and Young* ISGS staff, assisted by Ronald Gelnet of MARS Associates, Ed Samsel and Michael Wyatt of the Illinois State Museum, and members of the Center for American Archeology at Kampsville, set up sites and deployed 16 aluminum prism reflectors as a part of a joint USGS/ISGS Side-Looking Angle Radar (SLAR) experiment. The objectives of the experiment are to (1) mark shallow drainage in a broad upland divide east of Macomb for identification in interpreting the mosaicked imagery; (2) mark known archeological sites along the Illinois River to aid identification of similar sites; (3) mark the location of National Geodetic Survey horizontal control monuments to establish independent verification of cartographic accuracy of the SLAR mosaic to be prepared by a private contractor; and (4) determine the extent to which the microwaves penetrate a canopy of trees. State and federal agencies are cooperating on these experiments.

Satellite Image Map of Northeastern Illinois with the SSC Overprint, *Stohr, Hannah, and Joselyn* A color print of the Satellite Image Map of Northeastern Illinois overprinted with the yellow outline of the proposed ring corridor for the Superconducting Super Collider was used for the July cover of *Photogrammetric Engineering and Remote Sensing*, a journal published by the American Society of Photogrammetry and Remote Sensing. To make copies of this new overprinted version of the popular image map available to the public, a second printing of 1,500 copies was made. Several thousand of the image maps with and without the SSC overprint have been distributed at public meetings.

Derivative and Topical Maps

Slope Map of Illinois, *Smith and Berg* A slope map of Illinois is being produced using the 1:62,500 topographic maps--a coverage involving more than 250 maps. Land areas were divided into flat uplands, sloping uplands, and lowlands. Undulating uplands were subdivided into steeply, moderately, and gently sloping divisions based upon distance between contours. This map will be automated and used in conjunction with the stack-unit map of the state to better understand statewide areas of high and low potential recharge. It will also be used to screen sites for waste disposal facilities and help evaluate regions of potential landslides. The map should be completed in the fall of 1988.

QUATERNARY INVESTIGATIONS

Framework Studies

Geology and Hydrogeology of the Mahomet Bedrock Valley, *Kempton* Coauthored by P. C. Heigold and K. Cartwright of the ISGS and W. H. Johnson of the University of Illinois Geology Department, this report was originally three separate presentations at the 1983 Annual Meeting of the Geological Society of America (GSA) in Indianapolis. It will be published as a special paper in the GSA volume. To avoid duplication of illustrations and background information in the symposium volume, the authors combined their papers describing bedrock topography, glacial drift stratigraphy, and hydrogeology of the Mahomet Bedrock Valley.

Loess Research, *Follmer, Masters, and McKay* In response to a September tour to examine loess in the Mississippi Valley area, extending from Illinois to Louisiana, participants from four states and four foreign countries encouraged the leaders, L. R. Follmer, E. D. McKay, and J. M. Masters, to take a lead in loess research in the United States. Consequently, plans are in a preliminary stage to develop a loess research center in Champaign in affiliation with the University of Illinois to further research on loess in the United States, and to develop international

cooperation on loess research. Funding from the National Science Foundation is being sought to support the center.

Field Identification of Paleosols, *Follmer* Long experience and the long-term accumulation of paleosol profile data is providing information sufficient for the preparation of a field guide that will have broad appeal. A draft will be completed by spring 1989.

Quaternary History and Stratigraphy, Northeastern Illinois, *Hansel and W. H. Johnson, (University of Illinois)* Seven exposures were described to complete studies on the Wedron type section and the Lemont-Haeger correlation for papers being prepared on stratigraphic relationships among units in the Wedron Formation in northeastern Illinois. Lithofacies cross sections were constructed to illustrate relationships. Proposed lithostratigraphic changes were presented at the North Central Association of Engineering Geology Field Trip in the Chicago area in April.

Synthesis of Lake Michigan Lobe Radiocarbon Dates and Chronology of Events, *Hansel and Fisher* Radiocarbon dates on organics from beneath, beyond, within, and above late Wisconsinan deposits of the Lake Michigan Lobe in Illinois, Indiana, Wisconsin, and Michigan are being compiled into a single computer database with additional information (material dated, radiocarbon laboratory, location, stratigraphic unit, collector, references, significance), maps, and graphs to synthesize the chronology of events of the last glacial advance and retreat of the Lake Michigan Lobe. Seventy-five entries have been completed. An ISGS report is planned.

Revisions in Quaternary Stratigraphy, *Hansel, Follmer, and W. H. Johnson (University of Illinois)* Revisions of Quaternary stratigraphy are presently being evaluated including (1) adoption of the new diachronic classification system, (2) raising the rank of some established units, and (3) renaming units where necessary to comply with the 1983 Stratigraphic Code. A preliminary revision of time and rock stratigraphy for the Wisconsinan was prepared and mailed with a questionnaire to 50 midcontinent Quaternarists. Replies are being evaluated. Preparation of a new stratigraphic notebook describing Quaternary stratigraphic units is being planned.

Quaternary Environments and Processes

Glacial Sedimentary Environment Studies, *Hansel and W. H. Johnson (University of Illinois)* Study of the sedimentological characteristics of glacial deposits is continuing in an effort to model sedimentary environments and predict probable relationships among glacial materials deposited during Quaternary glaciation in Illinois. Several important sections have been studied in detail and lithofacies diagrams, clast fabric diagrams, and summaries of analytical data have been prepared. Understanding the geometry and genesis of lithofacies has important applications in groundwater studies, land-use planning, engineering properties, and locating landfills.

PALEONTOLOGY/PALYNOLOGY INVESTIGATIONS

Twelve scientists from five sections in the Illinois State Geological Survey (ISGS) contributed to paleontologic and palynologic studies during the report period. James W. Baxter, head of the Industrial Minerals and Metals Section, supervised the Foraminiferal Research Laboratory. Rodney D. Norby, Basin Analysis Task Force and curator of the ISGS Paleontological Collection, also supervised the Conodont and Acid-Digestion Laboratories. Russel A. Peppers, Coal Section, supervised the Palynological Laboratory.

Paleontology Studies

Paleontological Repository, *Baxter, Norby, Peppers, Shaw, Weibel and others* The Paleontological Repository receives, curates, and preserves the fossils and locality descriptions collected and studied by the staff as well as those studies by other scholars. The repository includes 81 formally catalogued and curated Survey collections, dozens of uncatalogued field collections, and several reference collections of international significance. A Paleontological Research Committee advises on research planning and management of the repository.

Repository Reorganization, *Norby* The curator, with the assistance of several other ISGS paleontologists (Devera, Jacobson, Mikulic, Shaw, and Wiebel), has sorted through approximately 600 of the more than 1,000 drawers of fossils in the stratigraphic collections and culled out fossils with poor or nonexisting locality or stratigraphic information. This process not only improves the utility of the stratigraphic collections, but it creates additional space for new studies. This culling process should be completed in the next fiscal year.

Fossil Loans, *Norby* Eight loans were made and three previous loans were returned. One of the returned loans was a large collection of Middle Devonian corals from the Herkimer No. 5 well, Coles County, Illinois. A publication by Dr. William A. Oliver, Jr., USGS, on these corals suggests some new paleogeographic interpretations. Although most coral species migrated into the Illinois Basin from the east, some coral faunules from the Herkimer well suggest some species migrated from the Williston Basin to the Michigan Basin and then into the Illinois Basin during Middle Devonian time.

Conodont Biostratigraphy of the Prairie du Chien Group, *Shaw, Norby, and others* Conodont microfossils, recovered from Prairie du Chien rocks from several regions of Illinois and from areas fringing the state, will provide more precise correlation of this Lower Ordovician rock unit within Illinois. The project has been expanded to include additional cores from Henry, LaSalle, Pike, and Warren Counties. Evaluation of the collections to date indicate that (1) a probable disconformity exists at the base of New Richmond in northern Illinois, (2) the New Richmond is middle Early Ordovician in age, (3) the Shakopee is late Early Ordovician to earliest Middle Ordovician in age, and (4) deposition of the Shakopee on the flanks of the basin continued into at least earliest Middle Ordovician time, although this portion of the section was removed by erosion in the Middle Ordovician. We are actively pursuing contacts with private industry in the hope of obtaining additional core material from these intervals. A preliminary correlation chart is being developed to correlate the Prairie du Chien Group throughout the Great Lakes region. Conodont-based correlations show that the recent discoveries of gas in the Michigan Basin units are, in part, coeval with the Everton Dolomite or the St. Peter Sandstone.

Conodont Biostratigraphy of the Ancell and Platteville Groups, *Shaw, Norby, and Votaw (Northwestern Indiana University)* This biozonation project has been expanded to include an additional four cores and six surface localities distributed from southeastern Minnesota to White County, Illinois, with the intent of constructing a north-south cross section of the Middle Ordovician rocks in the Illinois Basin. The goal is to establish the lateral and time-transgressive relationships of the Ancell and Platteville stratigraphic units. Processing of four of the seven cores to be utilized is nearly complete, and a preliminary report is planned by early 1989.

Age of Galena Group In Central Illinois, *Shaw and C. Hart (Ohio State University)* Conodont faunas from three cores from DeWitt, Douglas, and Champaign Counties are being studied to establish the age of the Galena Group in central Illinois. A preliminary evaluation of the conodont faunas (extremely abundant in this interval) should be completed by the summer of 1989.

Microfossils of the Grand Tower Type Section, *Devera* Numerous groups of microfossils were recovered from the type section of the early Middle Devonian Grand Tower Limestone; they include chitinozoa, scolecodonts, conodonts, ostracodes, foraminifera, possible calcareous algae and acritarchs. The algae (?) were previously unknown (Devera, 1987). A paper entitled "*Asphaltinoides* incertae sedis, a new genus from the Devonian of Illinois," appeared in the November 1987 issue of the *Journal of Paleontology.*

Conodont Biostratigraphy of the New Albany Shale, *Norby and Shaw* An updated conodont biostratigraphy has been formulated for the Upper Devonian/Lower Mississippian black shale of Kentucky (southeastern portion of the Illinois Basin) in cooperation with Frank Ettensohn of the University of Kentucky. This new biostratigraphy will provide greater precision in correlating Upper Devonian rock units throughout the Illinois Basin. The project is being funded by the National Science Foundation through the University of Kentucky.

Biostratigraphic Zonation of the Silurian in Central Illinois, *Shaw and Norby* A 4-inch diameter core of the complete Silurian section at the Lincoln Gas Storage Field in Logan County has been processed for conodont microfossils. The conodonts have been picked and are in the process of being identified. Conodonts should provide good biostratigraphic correlation of this central Illinois core to many of the type sections in northeastern Illinois and to the outcrop areas in western and southwestern Illinois.

***Taxonomic Study and Biostratigraphic Significance of the Mississippian Conodont Genus* Lochriea,** *Norby and von Bitter (Royal Ontario Museum)* This study redefines the Mississippian conodont genus *Lochriea* and makes it more useful as a biostratigraphic indicator. Several species, which will now be classified under this genus, have become very important in several international biostratigraphic charts. However, these species were not well understood because the constituent elements of each species had been misidentified. This study is nearing completion and a manuscript is in preparation for publication.

Trace Fossils of the Lower Pennsylvanian, *Devera, Jacobson and Nelson* The trace fossil project--a spin-off of the geologic mapping program in southern Illinois (COGEOMAP)--has provided important evidence for significant marine influence in the lower Pennsylvanian rocks of southern Illinois. Mounting sedimentologic and paleontologic evidence of inner-shelf marine and estuarine environments has challenged old views of the fluvially dominated Caseyville and Abbott Formations.

A portion of a major marginal marine-deltaic complex has been recognized within the Eddyville, Stonefort, Waltersburg, Glendale, and Creal Springs Quadrangles because of mapping and trace fossil assemblages (Devera, 1986). This project has been expanded to include the Goreville, Lick Creek, Cobden, Gorham, and Wolf Lake Quadrangles. The extension of this study is important because it should reveal the western portion of this large deltaic complex that developed early in Pennsylvanian time.

Trace fossil collecting in southern Illinois continues in the newly mapped areas. A manuscript for an ISGS Circular, which is being drafted, will discuss the importance, morphologies, and sample locations of trace fossils. A summary report is also in preparation as a supplement to the Geological Science Field Trips, conducted by the Educational Extension Section of the ISGS. The same report will also be used for a field trip planned in connection with the International Geological Congress, in the summer of 1989.

Biostratigraphy of Marine Zones in the Lower Pennsylvanian of Southern Illinois, *Jacobson and Norby* Over the past several years, including the year covered by this report period, samples of various marine strata encountered in the geologic mapping project in southern Illinois (COGEOMAP) have been collected both from outcrops and drill cores. Sampling extends into western Kentucky and southern Indiana. These samples are being processed for conodonts. The goal is to use the data to set up a marine biostratigraphic framework for the basal Pennsylvanian rocks (Abbott and Caseyville Formations) in the southern part of the basin as a complement to the palynologic data.

Paleocene Foraminifera from Southern Illinois: Biostratigraphy and Paleoecology, *R. Fluegeman, Jr. (Ball State University) and Masters* A 45-centimeter split-spoon sample from the upper Clayton Formation (Paleocene, Danian) from Mounds in Pulaski County, Illinois, was found to contain an abundant, well-preserved benthic foraminiferal fauna. Rare (less than 2 percent of the total foraminiferal fauna) planktonic foraminifera were also obtained from the sample. The planktonic foraminifera collected include *Subbotina pseudobulloides, S. triloculinoides*, and *Planorotalites compressus* and indicate an assignment to the *Subbotina pseudobulloides* Zone (Zone Plb).

The split-spoon sample was divided into five 9-centimeter interval samples for paleoecologic studies. In the obtained benthic foraminiferal assemblages, individuals of *Cibicidoides alleni* and

Anomalinoides midwayensis were quantitatively dominant. The obtained assemblages all indicate open marine paleoecologic conditions and water depths of less than 20 meters.

The assemblages of Paleocene foraminifera obtained in this study represent only the fourth locality in the Upper Mississippi Embayment to produce abundant foraminifera from the Clayton and they are the first assemblages studied quantitatively.

Palynology Studies

Working Groups on the Subdivision of the Pennsylvanian and Middle Pennsylvanian of the Subcommission on Carboniferous Stratigraphy (International Union of Geological Sciences), *Peppers* Work continues on the upper and lower boundaries of the Middle Pennsylvanian by the Middle Pennsylvanian Working Group in order to better define them and to recommend type sections. Most of the focus has been in the southwestern part (Oklahoma-Arkansas) of the Midcontinent where the Morrowan and Atokan Series were established. The boundary between the two series is the lower boundary of the Middle Pennsylvanian. Paleontologists are investigating the assemblages and stratigraphic ranges of animal fossils, and Dr. Peppers is studying the palynology of coals, especially those near the upper and lower boundaries of the Middle Pennsylvanian. The upper boundary of the Middle Pennsylvanian at the top of the Desmoinesian is biostratigraphically well defined, since it marks a major change in composition of faunas and floras. These boundaries and intervening fossil ranges and zones are being correlated with strata in Illinois. Results are transmitted to the chairman, P. K. Sutherland of the University of Oklahoma, who will present recommendations to the Subcommission on Carboniferous Stratigraphy.

In June 1988, Dr. Peppers was invited to become a member of the overall Working Group of the Subdivision of the Pennsylvanian. The International Union of Geological Sciences considers the Pennsylvanian as a subdivision of the Carboniferous System rather than a system as used in this country. The Subcommission will suggest subdivisions for the Pennsylvanian and recommend horizons for the stage boundaries that would be internationally accepted. The subdivisions will be defined on the basis of geologic ranges and distinctive assemblages of fossil animals and plants. A summary of palynological correlations between the Illinois Basin and other coal regions in the United States and Europe, which is being prepared, will include a stratigraphic range chart of representative Pennsylvanian spores and a correlation chart.

Pennsylvanian Working Group of the Society of Economic Paleontologists and Mineralogists, *Peppers and Lowry* The work of this group, of which Dr. Peppers is a member, overlaps that of the International Working Group of the Subdivision of the Pennsylvanian; several investigators belong to both groups. The emphasis of the SEPM group is on the processes of cyclic deposition of sediment, especially the widespread marine transgressions and regressions in the Pennsylvanian. Biostratigraphic correlations, including palynology, are important because they provide temporal control for interpreting the depositional sequences.

In May, Dr. Peppers attended a field trip in Missouri, Kansas, and Oklahoma in order to compare strata in the Illinois Basin with strata in the western part of the Midcontinent. Palynology permits correlations between the two regions so that depositional cycles can be traced over great distances. Coal samples were sent before the field trip by the chairman of the group for spore analysis as an aid in planning the trip, and samples were collected during the trip for further study. The trip focused on the Atokan-Desmoinesian and Desmoinesian-Missourian boundaries.

Correlation of Middle-Upper Pennsylvanian Boundary between the Illinois Basin and Northern Texas, *Peppers and Lowry* Dr. Peppers was requested to contribute to the guidebook for a field trip being planned for the 1989 South-Central Meeting of the Geological Society of America. The trip will focus on the Desmoinesian-Missourian boundary. Ammonoids, conodonts, and other microfossils have been used to delineate the boundary but there is a question about the results from some earlier palynological studies. Most of the rocks are of marine origin so this study will indicate whether palynology can be used to detect the major floral change in marine

sequences rather than just in nonmarine rocks. Several samples were macerated; a comparison with palynological data from the Illinois Basin indicates that samples from what was thought to be Missourian in age could be Desmoinesian in age or contain Desmoinesian spores that had been redeposited. Several additional samples from farther below and above what is thought to be the Desmoinesian-Missourian boundary are going to be examined.

Technology Transfer and Information Services

Fossil Plant Studies, *Jennings* A field guide to Pennsylvanian fossil plants of Illinois will soon be published in the ISGS Educational Series. This well-illustrated booklet, with its unique guide to collection localities, is expected to appeal to a large audience. Research is underway to follow up on problems encountered during the preparation of the field book--such as the use of Mississippian/Pennsylvanian fossil plants for correlating Illinois rock units and the poorly known fossil plants of the lower Pennsylvanian and upper Mississippian.

Coal-Ball Database for the University of Illinois Department of Plant Biology, *Gaines, Helm, Junkins, and T. Phillips (Plant Biology Department, University of Illinois)* The Computer Research and Services Section is processing 30,000 records of plant macrofossil assemblages found in coal balls from major coal seams in the Illinois and Appalachian. These data files are being used for paleoenvironmental reconstructions that will be the basis for an invited paper to be given by Dr. Phillips at the 1989 International Geological Congress.

Palynological Correlation of Major Pennsylvanian (Upper Carboniferous) Time-Stratigraphic Boundaries in the Illinois Basin with Those in Other Coal Basins, *Peppers* A poster illustrating palynological correlations of Pennsylvanian strata in the Illinois Basin, the Midcontinent, Appalachian Coal Region, western Europe, and the Soviet Union was presented in April at the 1988 North-Central Meeting of the Geological Society of America and in June at the Sixth Midcontinent Paleobotanical Colloquium.

GEOCHEMICAL INVESTIGATIONS

Shale Geochemistry

Geochemistry of New Albany Shale, *J. Frost* The geochemistry of black shales of the New Albany Group in Illinois is being studied to broaden our understanding of the deposition of these shales. Chemical analyses of 32 samples from the New Albany Group (Devonian-Mississippian) in the Illinois Basin were completed. The samples were either shales or nodules rich in trace metals. A report discussing relationships among organic carbon, iron, and pyritic sulfur in shales of the New Albany Group has been written. Data indicate that the sediments were deposited in an anoxic but not euxinic environment. As the amount of organic carbon in the sediment increased, pyrite formation and the degree of pyritization of the iron also generally increased.

Organic Geochemistry of the Anna and Energy Shale Members of the Carbondale Formation (Pennsylvanian), Illinois Basin, *M. Chou, C. Chou, and Dickerson* The purpose of this research is to better understand and predict sulfur variations. The sulfur content in the Herrin (Illinois No. 6) Coal has been shown to be related to the sedimentary environments of roof strata. Coal that is overlain by relatively thick nonmarine gray Energy Shale has a lower sulfur content than does coal overlain by marine strata of the Anna Shale and Brereton Limestone.

Preliminary results indicate that the organic-rich basal Anna Shale samples and overlying Energy Shale samples have distinctly different organic geochemical properties. These geochemical properties confirm that the organic-rich basal Anna Shale was deposited in a marine environment with its organic matter derived mainly from marine organisms, and the Energy Shale was deposited as crevasse-splay deposits containing organic matter derived largely from land plants. A sample collected from the upper portion of the Anna Shale differs in organic geochemical composition from other samples collected from the bottom of the Anna Shale bed. These results indicate that the organic geochemical properties of the Anna Shale are variable. GC/MS

investigations are underway on trace organic compounds of biological origin in extracted shale samples to further document the variation.

Biogeochemistry

Kinetic Isotope Effects in Biogenic Acetate and Methane in Anaerobic Sediments, *Risatti* In this joint project, the ISGS will work with investigators from the Chemistry and Geology Departments at Indiana University to determine the carbon isotopic fractionation in biogenic methane and acetate produced autotrophically and by fermentation. The goal is to understand the flow of carbon in anaerobic sediments in which biogenic methane (natural gas) may form. In recently completed experiments involving autotrophically derived acetate, we found that the bacterium, *A. woodii*, produces acetate approximately 56 per mil more enriched in carbon 12 than the carbon-dioxide substrate. These findings may explain the large range in the carbon isotopic composition in biogenic natural gas. We have also begun experiments to measure the carbon isotope effects occurring in acetate produced from sugars fermented by the same bacterium.

GEOTECHNICAL INVESTIGATIONS

Bedrock Conditions

Compressed Air Energy Storage (CAES) Activities, *Brower and J. Treworgy* Renewed interest in developing an operational power generation facility at the EPRI pilot project CAES site near Pittsfield in Pike County has involved Survey staff. Central Illinois Public Service Company requested our participation in their preliminary evaluation phase of the site for a 200 megawatt peakload power generation facility using CAES technology. Since CAES power generation from a buried sandstone aquifer is a new technology in the United States, CIPS wishes to engage the expertise of ISGS scientists in the fields of stratigraphy, structure, hydrogeology, and geophysics to view the planning, testing, and evaluation of the site conducted by their consultants. Our proposal has been submitted, however, delays in project startup have developed. The ISGS was also consulted concerning classification of the proposed wells under state and federal regulations (Underground Injection Control Program) for underground injection wells.

MINERALOGICAL INVESTIGATIONS

Research Studies

Soil Clays, *Hughes and Moore* In this project, studies are underway of the soil-forming processes that result in distinctive changes in mineralogical composition. The purpose of this project is to identify mineralogical "signatures" that indicate particular types of soil formation and to extend that knowledge to ancient occurrences. This year's developments include location of new samples containing poorly crystallized kaolinite and mixed-layered kaolinite/smectite, and preliminary studies of the genetic relationship between low- and high-charge vermiculite, smectite, and illite/smectite in weathering profiles.

Mineralogy, Mixed-Layered Compositions, and Illite Polytypes of Paleozoic Rocks of Illinois, *Hughes, Glass, and Moore* Developing special sample-preparation techniques for recognizing and measuring polytypes (structural types) of illitic materials is the current focus--part of an effort to define postdepositional environments and diagenetic histories of sedimentary rocks.

Quaternary Geology by Mineral Composition, *Glass, Moore, and Hughes* The mineral composition of Quaternary deposits and soils developed within these deposits is being used to reconstruct their history. Noteworthy advances within the past year are the development of a technique to recalculate clay mineral percentages in such a way that unaltered and altered samples can be compared. In addition, several sample sets have been analyzed in support of student- and professional-level Quaternary investigations. Preliminary attempts to use smear samples for improved mass balance studies of stream sediment loads have also begun.

XRD Laboratory Improvements for Mineral Analyses

***Preparation of a Manual for the X-Ray**, Moore and Gaines* The goal is to produce a manual that will provide three things: (1) a user-friendly guide to the use of the machines in the X-ray Lab; (2) descriptions of standard methods of sample preparation; and (3) information necessary for the service and maintenance of the equipment in the X-ray laboratory. This manual is approximately half finished.

***Operator Variance in Sample**, Hughes, Glass, and Moore* Progress was made in establishing quality-control standards for the operation of the X-ray diffraction laboratory. Variances measured include those within a given sample preparation and among preparations, from a single machine and among machines, and among operators, interpreters of a given data set, and types of interpretations. Blind duplicate analyses of at least 10 percent of each sample set has also become the standard for quality assurance in this area.

COMPUTER RESEARCH

Programming and Data Entry Research

***LEGAL Program**, Wilson and McKay* LEGAL, a program on the Prime 9955, converts legal descriptions of well locations into x,y coordinates for computer mapping. Revisions to LEGAL this year have greatly improved the accuracy of calculated coordinates and the well maps produced from it. An indispensable tool for plotting well maps, the program is written in Fortran and uses ARC/INFO to reference ILLIMAP, the digital public land survey grid of Illinois.

WELLOG Program, Pool An invention of the CRSS staff, WELLOG is a versatile menu-driven program that will enable geologists using the Prime 9955 computer to create cross sections of digitized wireline logs and prepare a copy for their publications. With this program, a log is digitized using ARC/INFO. The tops of units are picked by a geologist, and a shaded stratigraphic column is drawn next to the log. The current procedure of photographically reducing well logs that they can be published will be replaced by this program. WELLOG can plot a series of wells on one piece of paper, at any scale, facilitating the creation of cross sections. THe WELLOG program is the first program written at the ISGS using the new ARC Macro Language. It features pulldown menus for choosing options.

***WELLMAP Program**, Pool and Denhart* WELLMAP is a user-friendly computer program that works in conjunction with the Survey's Basic Well Data file on the Prime 9955 computer to produce a standardized map of selected wells. It requires little or no prior experience with computers to use it and allows flexibility in the choice of content and format of the map produced. Well points are plotted with the symbols that represent the well type, and the text accompanying each well displays any of several user-selected attributes. Available since November 1987, the WELLMAP program has produced almost 100 maps. The average time spent at the terminal to create a WELLMAP plot is about 15 minutes. The plot is then ready the following morning at 8:00 a.m. The WELLMAP program is currently being modified to work in the newest version of ARC/INFO so it will use pulldown menus, operate faster, and allow more options.

***Geologic Records Computerization**, Denhart, Helm, Junkins, Faber, and Zelinsky* Research efforts were concentrated this past year on the daily mail entry system and on noncompliance reporting:

- *Daily Mail Entry System* One essential element of the continuing automation of the Geological Records Unit, the Daily Mail Entry, System, has been completed and is in use. Data from records submitted by well drillers for wells in the state are entered in the system daily. Information in the system (such as kind of logs, run on a well, the logs received by the Records Unit, and total depth of the well) can be queried via a tie-in to the Prime 9955 computer. Updating can be done quickly and easily, and the file is kept current.

• *Noncompliance Reporting* The Geological Records Unit of the ISGS is charged to deliver to the Department of Mines and Minerals a list of the well operators in the state who have not filed the required records for their wells. In the past, this noncompliance list was compiled by a manual search of the unit's paper records. Now this list is generated monthly by computer and is up-to-date when it is made. Each month, operators not previously listed are checked to confirm the accuracy of the status. This reporting has resulted in operators supplying more data and making more information available to the citizens of the state.

***Data Entry Projects**, Helm, Junkins, Denhart, and McKay* Data entry supports activities on the Prime 9955 and on PC-aided projects in almost every section and unit in the ISGS.

Hardware/Software Evaluations

***Interactive Surface Modeling Software Testing and Evaluation**, Pool, McKay, L. Smith, Krumm, Denhart, Lecouris, Clawson, and C. Treworgy* Recognizing the need for a highly sophisticated computer contouring package to manipulate the data in the Survey's extensive well databases, CRSS staff evaluated the Interactive Surface Modeling (ISM) software, written by Dynamic Graphics. This software package, run on the Prime 9955, provided a diverse selection of output options, including contour maps, fence diagrams, block diagrams, and striking perspective views. The ISGS spent 2 months evaluating ISM. More than 25 different products were created during the evaluation period, including perspective views of the Precambrian surface and the Wabash Valley Fault System in the Illinois Basin.

***Advanced Systems Research** (Krumm, McKay, and C. Treworgy)* Members of the Computer Research and Services and Coal Sections have reviewed a proposed national standard for digital cartographic mapping. The standard is the product of three national committees and several subcommittees that have worked on developing the document for the past six years. The proposed standard includes a suggested format for digital data exchange that, when approved and implemented, will influence digital mapping efforts at the ISGS. One staff member participated in an introductory work session on the standards. Future involvement may include detailed testing of the proposed data exchange format.

***ORPHEUS, Geoprocessing Technology Integration**, McKay, Krumm, and Hines* The Prime Computer Corporation invited three ISGS staff to participate in a test of state-of-the-art software and hardware at Prime's corporate research facility in Natick, Massachusetts. The project, ORPHEUS, was designed to test a concept of land suitability analysis and planning in an intensive workshop using a full suite of software and real data. On one computer system, ORPHEUS integrated the ERDA remote-sensing software; ARC/INFO geographic-information-system software; ISM surface-modeling, contouring, and cross-section software; and computer-aided design (CAD) software. The workshop was recorded for a videotape presentation at the annual meeting of the American Society of Photogrammetry and Remote Sensing in St. Louis in March 1988. The project demonstrated the feasibility of using all the tested software together and conducting the entire analysis on a single Prime computer.

***Recommended Software for ISGS Microcomputers**, McKay and Computer Committee* The Computer Committee has recommended the following software for use on microcomputers to promote compatibility: WordPerfect for wordprocessing, 123 for spreadsheet, dBase III Plus or Oracle for databases, Freelance Plus for graphics, and Inmagic for bibliographies.

Computer Systems

***Survey Computing System Design**, McKay, Wilson, C. Treworgy, Yeko, and the Computer Committee* The Committee has prepared a report recommending a computing systems design to serve the Survey's research and service activities. The system, which will be funded from a variety of sources, utilizes a network of workstations to provide more computing power and more accessibility. It includes specialized software to manipulating seismic data, produce computer-drawn contour maps and cross sections, and provide high-speed relational database capabilities.

***Microcomputer System Design, Setup, and Troubleshooting**, McKay, Wilson, Kraus, Gaines, Pool, Graettinger, and T. Johnson* The Computer Section assisted in the design and setup of more than 30 microcomputers in the ISGS during the past fiscal year.

***Shutdown of the PDP 11/34 Computer**, Gaines, McKay, Denhart, and T. Johnson* In January 1988, the Survey's minicomputer, a PDP 11/34, was dismantled and shipped to Springfield as surplus equipment. Maintenance costs had risen to the level that price/performance factors were no longer favorable. Computer data and programs on the 11/34 were migrated to microcomputers and to the Prime 9955.

Technology Transfer and Information Services

***National Survey of GIS Use Among State Geological Surveys**, McKay and Leighton* In cooperation with the Association of American State Geologists, the ISGS conducted a nationwide survey of state geological surveys to assess their current use and plans to use computerized Geographic Information Systems in their research and service programs. Forty states responded to a form containing 27 questions. Results indicate that many state surveys are expanding their GIS activities, although only two or three have systems as large and data as comprehensive as the ISGS. The most popular software for GIS is ARC/INFO, which IDENR uses. In 1983, IDENR was one of seven ARC/INFO installations nationwide. Today, there are thousands of installations internationally. The average state survey has a GIS staff of three and one-half fulltime employees (FTE). Many believe that GIS will greatly alter how they perform their work.

***Soil Chemistry Maps, Department of Agronomy, University of Illinois**, Pool and McKay* The ARC/INFO contouring package, TIN, was used on the Prime 9955 for several projects to create contour maps and perspective views. This work included the creation of a contour map of the rubidium content of Illinois soils for the Department of Agronomy at the University of Illinois. The contour map was combined with counties and township lines; the custom map will be published.

***ILLIMAP Data Tape**, McKay and Wilson* During the past year, the ISGS distributed six computer-tape copies of the IBM version of the ILLIMAP digital database to industry and the public. This file of section corners for the Public Land Survey of Illinois is used primarily in the oil industry to plot well locations.

***Fulton County Landfill Siting Maps**, L. Smith, Krumm, and McKay* Under contract with STS Consultants, Ltd. of Northbrook, Illinois, the Computer Research and Services Section used the GIS on the Prime 9955 to provide basic geologic factors for Fulton County. The data, provided in map form, were presented to the public by STS. This project illustrates the utility of the GIS, which produces data quickly and in polished form. Camera-ready copy and slides were provided.

***Workshops, Demonstrations, Classes, and Seminars**, McKay, Krumm, Pool, L. Smith, and others* Various presentations describing computer methods were given this year for more than 150 individuals from universities, government agencies, industry, and the private sector. Representatives of the Illinois Department of Mines and Minerals (Land Reclamation Division), Iowa Geological Survey, remote-sensing students from the Department of Geography and Landscape Architecture at the University of Illinoisgraphy, USDA Soil Conservation Service, county and regional planning groups, and others reviewed the computing activities at the ISGS.

SCIENTIFIC SUPPORT SERVICES

Analytical Chemistry Services

Fourteen different techniques were used to make 13,000 determinations in more than 1,700 samples from 34 counties in Illinois. Techniques used were atomic absorption spectrophotometry, ASTM standard methods, coulometric analysis, gravimetric analysis, inductively coupled plasma-emission spectrometry, instrumental neutron activation analysis, liquid scintillation counting, photographic optical-emission spectrography, energy dispersive X-ray fluorescence spectrometry,

wavelength dispersive X-ray fluorescence spectrometry, gas chromatography, high-performance liquid chromatography, gas chromatography-mass spectrometry, and rock-eval pyrolysis.

Isotopic Geochemistry Services

Isotopic Analysis Service Laboratory (IASL), Liu, Fisher, Riley, Hackley, and Coleman As a result of equipment purchased through the Build Illinois program, the ISGS is now able to make stable isotope analyses available to the scientific community. Facilities are available for isotope analyses of carbon, oxygen, nitrogen, and sulfur on a variety of geologic and archaeologic materials. Stable isotope analysis has become a standard tool in many types of geochemical investigations.

During the reporting year, the IASL completed 1054 carbon-isotope-ratio determinations and an equal number of oxygen determinations. Approximately 15 percent of these analyses were for quality assurance and standardization; the remainder distribute as follows: 45 percent for anthropological research conducted by Stanley Ambrose (Department of Anthropology, University of Illinois), 15 percent in support of the Radiocarbon Dating Laboratory, 15 percent in support of various ISGS research projects (oil/source rock correlation, natural gas composition, limestone composition), and 5 percent in support of geological research with the Illinois State Natural History Survey. Approximately 55 percent of these samples were supported with outside funds.

Before the end of 1988, hydrogen analysis capability is expected to be added to the IASL. This will be useful in groundwater investigations as well as other geochemical applications. There is also a pressing need for nitrogen analysis, and the IASL is actively exploring methods to provide this capability.

Radiocarbon Dating Laboratory, Liu, Fisher, McMillion, and Coleman Radiocarbon (C-14) age determinations are provided as a service to both the geological and archaeological community in order to assist them with their research. The ISGS operates the only Radiocarbon Dating Laboratory in the state (and one of only two in the midwest) and thus provides a valuable service not only to other Survey scientists, but also to educators and researchers throughout the state.

During the past 12 months, 183 radiocarbon age determinations were performed on geological and archaeological samples for scientists throughout Illinois. Approximately, 60 percent of the samples processed during this period were funded through users' research projects. The other 40 percent unfunded samples were either submitted by ISGS Quaternary geologists or graduate students in Illinois working on their dissertations.

In the past year, the radiocarbon dating laboratory has been active in providing important radiocarbon dates for ISGS research on the Superconducting Super Collider site and Lake Michigan shoreline erosion.

Coal Analysis Laboratory Service

Coal Analysis Laboratory, Chaven, Hurley, Garilovic, and Ruch The Coal Analysis Laboratory served the growing demand for analytical service to support many research efforts at the ISGS and other institutions such as the University of Illinois, the University of Chicago, and Eastern Illinois University. The number of coal and coal-related samples received this year approached 2,000. Almost 12,000 analyses were required in support of more than 20 projects. Because the credibility of so much research depends on the reliability of this analytical service, quality assurance/quality control is rigidly practiced. The computer program receiving each new analytical request is constructed to include the result of a quality-control sample analyzed that day. The results from control samples are routinely plotted on the computer to monitor the precision and accuracy of each type of analysis.

Build Illinois funds were used to install a microtrac particle-size analyzer in the ISGS Coal Analysis Laboratory. With the latest laser light-scattering technology, the instrument can analyze

particle sizes from 700 to 0.7 microns in a few minutes. The report of the analysis--complete with graphic displays of particle size--is available through interface with a personal computer.

Sample Services

***Location of Isotopically Characterized Coal Samples**, Hackley, Liu, and Coleman* The stable isotope tracer method has been effective for monitoring sulfur mobility during thermal and chemical treatments of coal. The target of this project was to locate a reasonably large coal sample with a large isotopic difference between its organic and pyritic sulfur, and to include it in the Illinois Coal Basin Sample Program (IBSCSP) at the ISGS. Isotopic analyses of 120 coal samples led to a decision to collect three large coal samples, each weighing approximately 150 pounds from a central Illinois coal mine. The sample that exhibited the largest isotopic difference between its organic and pyritic sulfur and the least oxidation was processed and is currently available for the IBCSP.

***Maintenance and Distribution of the Geochemical Standard PuSh**, Moore* Purington Shale (PuSh) is the recognized international standard for chemical analysis of shales. Current work is expected to establish it also as an international mineralogical standard. About 500 bottles of this sample of PuSh are stored in the ISGS repository from which we make deliveries to requesters. Providing this standard material is not only a service to the scientific community, but our scientists often learn from those making requests about new directions in clay science research.

DATABASE ENHANCEMENT

***Stack-Unit Map--A Statewide Database,** L. Smith, Krumm, Pool, Taylor, and Graettinger* The Computer Section and the Groundwater Section automated part of the Stack-Unit Map of Illinois and incorporated it into the GIS. This is a statewide database, digitized on the Prime 9955 at a scale of 1:250,000. The Stack-Unit Map has been used for several siting projects this year.

***Devonian and Deeper Wells Database**, Denhart, J. Treworgy, Graettinger, Pool, and Krumm* A computer file of more than 13,000 oil and gas wells finished in or below the Devonian is now available for use on the Prime computer.

***Maps of Deep Tests in Illinois**, J. Treworgy, Pool, Krumm, Graettinger, and Denhart* A map series produced with ARC/INFO on the Prime computer shows locations of all wells that reach specified stratigraphic units in the southern three-fourths of Illinois. The database for the stratigraphic information was the Devonian and Deeper File, including all wells that were drilled through 1979 and reach the Devonian or deeper at total depth. The maps were produced as a basis for defining an optimum grid for our Cross-Section Project, but they are extremely useful to anyone needing data on Devonian or deeper units.

Each map is accompanied by a list of all wells shown on the map. The wells are listed in location order and include information on well name and location, total depth, stratigraphic unit at total depth as well as logs, samples, and cores available at the ISGS. These maps and well listings are being custom-produced upon request by staff and the public.

***Revision of ISGS Four-Digit Stratigraphic Code**, J. Treworgy and Atherton* The ISGS four-digit stratigraphic code file on the Prime computer was modified, corrected, and updated for pre-Quaternary units. The changes were approved by staff of several ISGS sections as well as by the Stratigraphic Nomenclature Committee. This file is used throughout the ISGS as a means of encoding stratigraphic data. Periodic updating is essential.

***Catalog of Pre-Galena Group Rock Cores of Illinois**, Shaw and Sargent* In response to many inquiries about lower Paleozoic rock cores as potential reservoirs for hydrocarbons, sites for waste disposal, natural gas storage, and compressed-air energy storage, a catalog of Middle Ordovician and older cores was prepared. The catalog of more than 125 cores contains a

stratigraphic summary of each core, a generalized chart of the stratigraphic names, and maps showing the cores available for each of five stratigraphic units. Final review of the manuscript is complete; publication is expected by winter 1988.

Mineral Industry Database, *Pool* The Mineral Industry Location Subsystem (MILS) tape was converted to ARC/INFO format on the Prime 9955, adding 793 datum points to the CUSMAP database. .These data include owner, commodity, mine activity, and location. The MILS data contain 25,000 datum points in a six-state region--2,537 points in Illinois. The data are available to users of the Prime computer network and have been utilized by numerous Survey projects.

Petroleum Information Database Acquisition, *Yeko* Data from more than 40,000 oil and gas wells have been acquired from Petroleum Information in exchange for ISGS verification of the data against our files. These data contain geologic tops, completion information, logs, and other data. They are currently on the Prime 9955 computer and available for staff use.

Gravity, Magnetic, and Other Data for the Paducah Quadrangle, *Pool and T. Johnson* The CUSMAP project has implemented data exchange between the USGS and ISGS. The USGS has provided geographic data for a four 7.5-minute quadrangle pilot study, including hydrology, roads, railroads, and transmission lines. These same data will be made available for the entire Paducah 1°x2° Quadrangle. The USGS has provided two complete geophysical data bases for the entire Paducah quadrangle: Bouguer gravity and aeromagnetic data. These data were delivered in a gridded format, transferred to the Prime 9955, contoured, and combined graphically with different data sets to create some striking maps of the Hicks Dome region of extreme southern Illinois.

Benchmark Database, *Scoggin, Gaines, and McKay* The NCIC office and the Computer Research and Services Section are constructing a database that will permit rapid and precise response to public requests for information on the location of surveyed benchmarks in Illinois. When complete, the data will be available via telephone for inquiries from engineers, surveyors, and others. The file is being developed on the Prime GIS to enable the plotting of benchmark locations along with other attribute data. The database contains the type of benchmark, year, stamping on the benchmark, and a general description of the benchmark location.

Quadrangle Database, *Gaines and Scoggin* Created in cooperation with the NCIC to respond to requests for 7.5- and 15-minute topographic quadrangle maps, this database on the Prime 9955 contains age, status, availability, and other attributes.

Samples Database, *Wilson, Harvey, McKay, and others* Work began on the design of a computer index for the thousands of samples analyzed by ISGS laboratories. When completed, the index will facilitate identification of analytical results by area, well number, sample number, laboratory, and other attributes.

Earthquakes Database, *Gaines, McKay, and Krumm* Earthquake data obtained from St. Louis University have been incorporated into the Prime GIS database. The data include all recorded earthquakes from Illinois, Kentucky, Missouri, and Indiana. They contain epicenter locations, magnitudes, intensities, depths, and other attributes of pre-1984 earthquakes.

Pavement Performance Database for the Civil Engineering Department, University of Illinois, *Krumm and Flowers (University of Illinois)* The ISGS and the University's Civil Engineering Department have been using the ARC/INFO GIS to compile information on interstate highways in Illinois. The database includes more than 400 characteristics describing pavement durability, traffic volume, and other factors affecting the physical condition of interstate highways.

Master Mailing List System, *Denhart, Junkins, and Helm* This project is a computerized file of address information aggregated on the Prime 9955 from a variety of mailing lists. During the past year, five new categories of entries were added to the file bringing the total number of address entries to more than 22,000.

Administrative and Technical Support Services

ADMINISTRATIVE AND TECHNICAL SUPPORT SERVICES

Vital operating functions support the Survey's research and service programs. Included are budgeting, accounting, and financial reporting; timekeeping, counseling, and advising human resources; cataloging, searching, and locating library references; receiving and distributing incoming mail, commodities, and equipment as well as processing orders and shipping publications, maps, and other materials; maintaining the information office and the Illinois affiliate office of the National Cartographic Information Center; conducting public field trips, dealing with a variety of inquiries, and distributing educational materials; overseeing media and legislative relations; fabricating, maintaining, and repairing scientific, office, automotive, and other equipment and instruments; supervising the word-processing system and arranging changes in telephone programming and billing; providing editorial, graphic, typographic, duplicating, and other publications services; and planning and supervising new construction and building renovations.

Basic to research and service efforts within the Survey and for the public and private sectors are the Geological Records Unit and the Geological Samples Library. The documentation of Illinois geology maintained by these two units and the Reference Library is the heart and soul of the Survey's activities and a basic source of information for private industry, government agencies, and the general public.

WORD-PROCESSING CENTER

Services provided by the Word Processing Center include revising manuscripts that are on the NBI system, transferring documents from the NBI to WordPerfect, supplying secretarial services for the Administrative Group, keeping records for the Contracts and Grants Office, and arranging for changes in the telephone system and associated billing. Staff handle requests for maintenance provided by the University of Illinois Physical Plant, vehicle reservations, mail distribution, and loan copies of out-of-print ISGS publications, and also provide an interface between the Administrative Group and the various departments of the University of Illinois.

During the reporting period, four NBI terminals were traded for four 2000 NBI terminals to enable software for the NBI System 64 to be upgraded, thereby allowing personal computers to be linked into that system. A computer, purchased for the office, was hooked directly to the NBI System, adding the capability of converting NBI documents to WordPerfect and the reverse process. With expanded knowledge and techniques, the staff trained other personnel in more efficient ways of typing and transferring information between the NBI and word-processing systems. As a time-saving measure, the staff learned to send typewritten documents through an optical character reader, permitting corrections to be made on a word processor without rekeyboarding the manuscripts.

All press releases, reports, contributions to outside journals and newsletters, fact sheets, correspondence, and special meeting literature prepared by the Public Information Officer was handled by the Word-Processing Center. During peak production periods, both staff members assisted with this work; on a regular basis, one person allocated about one-third time to the public information effort.

Responsibilities were also added by the Contracts and Grants Office. Records of University of Illinois employees, contracts and grants, and proposals were kept on the NBI, and monthly reports were prepared for the director of the Illinois Department of Energy and Natural Resources. The staff also set up files for proposals, filed changes in status forms, and copied documents for this office.

The new telephone communications system created many new tasks for the staff. Each personnel move within the Survey required changes in the program and billing in addition to the routine reporting of troubles with telephones.

Whether the problem was a burned-out light bulb, a door lock or adjuster, elevator or radiator malfunction, maintenance requests made to the University of Illinois Physical Plant were prepared by the unit. In addition, the staff regularly updated the telephone list and hall staff directories and assisted daily with vehicle reservations, often rearranging vehicle assignments to meet staff needs.

On the basis of a 4-month sample, the mail count projected for the reporting period included 92,063 pieces of mail handled and 6,448 items received for the Library. These figures indicate a slight increase in mail handling of more than 2,000 single pieces, while Library receipts dropped approximately 1,136 items.

BUSINESS AND FINANCIAL SERVICES UNIT

This unit became an integral part of the Administrative Group on August 21, 1987. Demands for increased services and new systems led to automating the accounting for state appropriated funds and installing the hardware and software to implement the automation of contracts and grants accounting. GASII software used by the Illinois Department of Energy and Natural Resources (IDENR) and associated hardware were installed in October 1987. Later in the year, an online computer connection was established to the accounting system at the University of Illinois, affording online inquiry on the status of payments and purchase-order processing at the university.

At the request of IDENR's Springfield Office, the unit assumed responsibility in October for the accounting for the Geological Survey's portion of the Lands Unsuitable for Mining Program (LUMP), which previously had been handled for all three Scientific Surveys by the Natural History Survey. With the cooperation of the Word-Processing Center, staff implemented another request from IDENR by initiating an accounts-receivable reporting procedure to the Comptroller. The new procedure, which took effect November 15, 1987, required automation of more than 10,000 transactions. Accounts receivable are now reported quarterly to the State Comptroller. With the new calendar year 1988, the unit also assumed the fiscal responsibility for accounts related to the Groundwater Protection Act.

Among the highlights, the unit underwent an external audit, which generated no material findings. The staff also made four budget submissions. In June, the unit initiated internal testing of the software and began entering data for the automated contracts and grants accounting system and established goals for the coming fiscal year.

Additional services included the presentation of a seminar on contracts and grants forms to the Survey's principal investigators and a seminar on credit card procedures for the staffs of the Information and the Geological Records Units.

The unit also provided more comprehensive monthly reports to group heads and the Chief with the status of accounts and funds available at all times and with a monthly analysis of outstanding commitments and allocations to each group for commodities, contractual services, and travel.

HUMAN RESOURCE OFFICE

During the past year, considerable emphasis was placed on affirmative action and equal employment opportunity. ISGS, in conjunction with IDENR and the Board of Natural Resources and Conservation, is dedicated to the principle and practice of equal employment opportunity and is in full compliance with all federal and state laws, orders, and regulations for Affirmative Action (AA) and Equal Employment Opportunity (EEO). Arrangements were made with the Illinois Department of Human Rights and IDENR's Personnel Officer to present to ISGS staff members a 2-day seminar on basic AA/EEO regulations and IDENR's procedures.

Policies, procedures, forms, and guidelines for filing grievances and discrimination complaints were put in place. During the past fiscal year, a policy on absenteeism, tardiness, and abuse of sick

leave was also developed and implemented. In addition, posters on sexual harassment, the Employee Assistance Program, AIDS, and minimum wages were placed on the bulletin boards in ISGS, and brochures were distributed to the staff.

To allow for continued growth, development, and an awareness of new rules and regulations, the staff of the Human Resource Office attended seminars and workshops regarding human resource management. Topics of some of these workshops/seminars were AIDS, alcoholism and substance abuse, sexual harassment, employee assistance, and employer liability under federal and state affirmative action law. In addition, the Human Resource Manager is a member of the American Society for Personnel Administration and attends monthly meetings of the local chapter, the Champaign-Urbana Personnel Association. These meetings allow an opportunity to hear knowledgeable speakers in the field of human resource management.

To monitor EEO and AA progress, the office prepares and submits quarterly workforce analysis reports to IDENR's Springfield office. These analyses show the distribution of women and minorities arranged in EEO categories: 65 percent of ISGS staff are men; 35 percent are women; 91 percent are whites; 2 percent, blacks; 6 percent, Asians; and 1 percent, Hispanic.

The Immigration Reform and Control Act of 1986 has had a major impact on employment policies and procedures. The Act requires all employers to obtain evidence of U.S. citizenship or valid authorization of employment for aliens. The Human Resource Office contacted all continuing employees hired between November 7, 1986, and May 31, 1987, and implemented a system for all new employees to provide the required documentation.

The Human Resource Office also gathered demographic information from each staff member preparatory to establishing an automated information system. This system will include, but is not limited to, staff turnover; AA/EEO reports; new hires/terminations within a given period; employee profiles; performance and salary histories; workforce analysis reports; absenteeism within a section/unit including duration and reasons, deficit balances, and vacation schedules; training including assessment of needs, management, tracking both in-house and outside courses, collecting evaluative information, and development of history; summary of benefits to staff (insurance carriers, coverage, coverage of dependents, accidental death and dismemberment coverage); notices to staff of vacation and sick leave accrued including breakdown by day and reasons; and verification of employment of individual staff members. When fully developed and implemented, this system is expected to reduce preparation time in completing narrative and statistical reports for management, supervisors, and staff members.

Effective January 1988, the duties and responsibilities for the administration and processing of benefits were transferred to the Human Resource Office from the Business and Financial Services Unit. This includes group insurance, life insurance, retirement, deferred compensation, withholding cards, administration of savings bonds drives, and processing savings bonds forms. During the first 6 months following this transfer (January 1 through June 30, 1988), the Human Resource Office processed 46 status of participation reports, distributed 94 forms, responded to 102 inquiries from the staff, made 59 changes on tax withholding cards, and 75 changes on insurance forms. When Central Management Services offered a benefits choice period from May 1 through June 30, 1988, the Human Resource Assistant held an information meeting for the staff on state-sponsored health and life insurance, dental coverage, dependent care, and deferred compensation. Also, a facts sheet on ISGS benefits was developed for employees.

The Board of Natural Resources and Conservation approved a revised Common Policy and Information Manual in October 1987. Upon receipt of printed copies, the Human Resource Office distributed registered copies of the manual to administrators and each staff member, and verified such distributions via signoff sheets.



Operating the blueline machine *(top)*, is Dennis Reed. Demonstrating the new laminating equipment is Ed Scoggin *(bottom)*. Both are members of the Public Information Unit.

The Human Resource Office received 561 applications in response to the 128 ads placed in newspapers and professional journals and posted announcements for 33 searches opened to recruit new personnel. The Human Resource Office received 1,110 applications in response to the ads. One-hundred eight candidates were interviewed and ultimately 69 new staff appointments were processed. Letter responses were written to most of the applicants. The Human Resource Office also acknowledged all letters of inquiry, which totaled 1,752. Special reports were provided to Survey management as needed.

PUBLIC RELATIONS AND INFORMATION UNIT

Numerous changes to the unit were brought about during the past reporting period. Walls were moved and doorways created to give access to areas and create space for additional functions. Remodeling created an office for the Illinois affiliate of the National Cartographic Information Center (NCIC), which was added to the unit, as well as space for a laminator purchased during the reporting period. This new equipment allows film to be applied to maps and documents to improve their permanence. Added responsibilities for the unit also included operation of the blueline machine and the responsibility for maintaining and developing mailing lists.

Public Relations

When established in January 1987 as a separate entity, the Public Relations Unit was charged with informing the public and decision makers about the Survey's research and service programs and significant events. To this original thrust has been added the responsibilities for governmental relations and selected strategic planning.

Providing a closer relation between the ISGS and such bodies as the Illinois General Assembly, the Springfield office of the Illinois Department of Energy and Natural Resources (IDENR), the Governor's subcabinets, the Society for the Illinois Scientific Surveys (SISS), news media, target groups, and the public, this unit provided a continuous flow of in-depth information. News of ISGS scientists' research and service activities was disseminated through press conferences and meetings for special-interest groups; articles for magazines, newsletters, and journals; personal letters to the ISGS constituency; speeches; press releases; reports; brochures; and public displays. This spring, the unit planned and executed the Survey's first breakfast meeting for legislators covering a new program to enhance and improve the recovery of oil from Illinois reservoirs.

During the reporting period, information was sent to members of the Illinois Appropriations, Energy and Environmental committees to keep them abreast of ISGS activities. On a monthly basis, the latest information on major research efforts has been channeled through IDENR's Springfield office to the Governor's subcabinets on Economic Development and Natural Resources, thereby providing department directors and the governor's staff an update on ISGS research and its potential impact on the economic and environmental well-being of the state as well as its resources.

In addition, articles were prepared for the SISS magazine, *Nature of Illinois*, the American Association of State Geologists (AASG) newsletter, the Illinois Superconducting Super Collider (SSC) newsletter, and IDENR's newsletter, *Illinois Resources*. Throughout the year, radio interviews were arranged for IDENR's news programs aired by radio stations throughout the state. The unit's staff of one also assisted IDENR with a media conference announcing the completion of the 7.5-minute quadrangle topographic maps and administered a jointly held news conference with the USGS, the Indiana Geological Survey and the ISGS concerning their research efforts on Lake Michigan. In addition, a media event was held at the new earthen liner project, the only study of its kind currently under way in the United States. Besides teaming media with scientists working on specific issues of interest, the unit working with staff prepared press releases on personnel changes, awards, or special recognition; geological science field trips; the earthen liner study; coal cleaning projects; seismic mapping of the area proposed for the SSC tunnel; effects of drought on building foundations; Illinois' native rock for a national monument; and the Geoscience Institute's Midcontinent Forum. Announcements and press releases were also prepared to market new publications and maps, while a catalog promoted maps available through the Survey. In addition, media contacts were made in the southern and northern parts of the state to deliver packets of information about major ISGS projects.

Displays were taken to the AASG national meeting, the Illinois State Fair, University Day at the University of Illinois, the legislative reception held by SISS, the Illinois Oil and Gas Association, and local and University of Illinois events. To upgrade the ISGS displays, fund-raising efforts are in progress to purchase an exhibit backdrop for the 28th International Geological Congress to be held July 1989 in Washington, D.C. An initial $2,000 contribution was received from A. E. Staley.

Finally, an internal calendar of events was created to lend cohesion and timeliness to staff efforts. On a monthly basis, the calendar features deadlines for proposals, reports, news information, and special events taking place at or involving the ISGS.

Information Office

General inquiries about the Survey from visitors or people calling or writing are handled by the Information Office staff. The staff also deal with telephone or written orders for ISGS publications and maps. As a convenience to customers, payment for the Survey's products, including well log copies, can be made by Visa or Mastercard credit cards.

A comparison of total sales for fiscal years 1988 and 1987 showed that overall revenue was off $552, principally due to a drop in the sales of the statewide Satellite Image Map of Illinois and the regional Satellite Image Map of Northeastern Illinois, which had revenues of $3,147 and

$1,432, respectively, in FY88 compared with $17,454 and $8,280, respectively, in FY87. However, sales of six other products increased during this reporting period. Sales of well log copies increased $7,513 with sales totaling $46,887; USGS maps were up $8,629 with sales of $41,822; ISGS maps, up $1,315 with sales of $4,620; blueline, up $801 with sales of $4,321; publications, up $3,152 with sales of $13,280; information sheets, up $811 with sales of $2,162.

During the past year, the Information Office staff was reduced from two persons to one. Because the level of inquiries and office visitors has kept pace with previous years, the staff has sought avenues to increase productivity. In this regard, a doorway was created between the Information Office and the map storage area to give easy access to maps often required by visitors and over-the-counter customers. The installation of the communications system allowing outside calls to be placed directly to ISGS personnel has eased the strain on the office, greatly diminishing the number of general telephone calls received on the incoming Survey number answered by the Information Office staff.

Mail Room

The central receiving and distribution center for office supplies and all ISGS publications and maps is the Mail Room. Stocks of all in-print materials are maintained there to fill orders and distribute to the staff. To improve the overall efficiency of this area, which also lost a staff member, most maps were consolidated from the loft area to the map storage rooms and well log copiers were moved to the main floor, allowing the operator to assist with Mail Room and supply functions or answer the telephone. Space was created for the copiers by moving older publications to the loft and storing only current publications on the main floor of the mail room.

During the reporting period FY88, the following maps and publications were distributed (FY87 is included for comparison):

	FY87	FY88
ISGS publications	25,083	32,655
USGS maps	16,730	27,502
ISGS blueline maps	2,271	3,470
ISGS maps (including satellite image)	12,302	15,034

Individual orders filled for the period numbered 6,058, an increase of 1,705 over the preceding year. Postage meter use amounted to $25,772 compared with $22,891 in FY87.

Receiving shipments, bulk mailing, inventory control, filling and shipping mail/phone orders, and other related duties are handled in the Mail Room. In addition, data are supplied to Computer Research Services for maintaining and updating the 22,960 names in the computerized mail lists file. (From this bank of names, mailing lists are developed for new products or special mailing requests.) Special projects during the reporting period included a study of publications sold over recent years to help determine printing and inventory requirements. In addition, a study was made of postage received and paid on orders to ascertain whether adjustments were required with the new postal rates.

Duplicating Services

Equipment in the Duplicating Service Shop this past year made 2,624,365 impressions, an increase of 330,377 impressions over the reporting period for FY87. Impressions consisted of reprints, monthly drilling reports, Illinois Mineral Notes, Environmental Geology Notes, Illinois Petroleum series, contract/grant reports, the Annual Report for FY88, fact sheets, speeches and handout materials for the legislative meeting, a county-by-county listing of projects for FY87, fliers, field trip guides, announcements, letterheads, envelopes, and forms. Among the attractive high-quality color printing jobs last year were several issues of Geonews (since printed outside because of press constraints), a three-color satellite map brochure, a three-color Christmas map catalog, and the cover for the Annual Report. Each presented its own challenges. In addition,

the press operator met many deadlines, including production on short notice of documents prepared for the SSC project, guides for field trips, and handouts for meetings.

During the last reporting period, the blueline equipment was moved from the Publications Unit to the Duplicating Shop. With the use of a new fast-exposure polyester film, Mylar exposures and developing are now performed on the blueline machine. Reproductions on the blueline equipment included the following:

	1986-87	1987-88
Oil and Gas Development	1,594	2,442
Illinois Coal Mines	293	580
Other	291	1,166
Northern Illinois Planning Commission (Geology for Planning)	232	422

Mylar reproduction in the shop for May and June 1988, the only two months of experience with the new processing film, included 78 Mylars for Illinois Coal Mines; 70 for other categories; and three for the Northern Illinois Planning Commission.

Well Log Copy Service

For the fourth year, the ISGS has copied well logs requested by customers in person, by mail or by telephone. Comparing figures for this reporting period with FY87 figures in parentheses, the Survey produced 8,416 (8,113) logs; 52,991 (33,816) single data sheets; 199 (78) logs for wells greater than 6,000 feet deep; and 356 (1,597) parts of logs.

National Cartographic Information Center

Since September 1987, the Illinois affiliate of the National Cartographic Information Center (NCIC), located at the ISGS, was incorporated in the Public Relations and Public Information Unit. Its staff of one had office conferences with 390 external visitors and made 1,285 telephone responses to information requests. Reports on program areas follow.

Cooperative Topographic Mapping *Scoggin and DuMontelle* Three separate projects for completely new editions of 58 7.5-minute quadrangle topographic maps are presently under way. Two of the projects, with a total of 26 quadrangle maps, are jointly funded by Illinois and the USGS. The third project, with 32 quadrangle maps, is funded entirely by USGS. The 1:100,000-scale, 30- by 60-minute quadrangle planimetric map series is complete for Illinois. The 46 maps in the series are being converted from planimetric to topographic format. Forty-four planimetric maps and one topographic map have been produced in the 1:100,000-scale county map series. Two additional county maps, Monroe and Warren, are in preparation.

Automated Survey File Information *Scoggin* Data entry has begun for the computerized benchmark file. The Illinois NCIC affiliate is reviewing the description of every vertical control mark of record in Illinois and including pertinent information prior to adding the description to a benchmark master file. The descriptions as modified can be retrieved by 15- or 7.5-minute quadrangle name, county name or township and range. Each record also includes the elevation of the mark, its approximate distance from the nearest section corner and its location relative to the nearest populated place. Horizontal data (Illinois plane coordinates and latitude/longitude) also are included in the description of any mark for which such values have been established.

Other NCIC Affiliate Activities *Scoggin* Two information leaflets have been prepared by the NCIC affiliate. A flier describing the 1:100,000-scale series of county maps of mined areas, recently updated by the ISGS Coal Section, has been distributed to representatives of the coal industry, real estate and insurance interests, engineers, surveyors, building contractors, and county officials. The second leaflet, which describes the 7.5-minute quadrangle topographic series of maps of Illinois, is in reproduction and will be distributed later this year.

PUBLICATIONS, GRAPHICS, AND PHOTOGRAPHY UNIT

In 1988, the ISGS Publications operation began the transformation from traditional cut-and-paste production to streamlined computer composition, camera-ready output via laser printer, and designer software. The equipment upgrade had been planned for some time--to speed and simplify production, create new products, improve the work environment, and support efficient use of staff expertise. But the changes of 1988 began with the challenges of 1987.

Superconducting Super Collider In April 1987, the ISGS Publications operation joined in the state's major effort to propose a site for the SSC in Illinois. Our main job was to take graphic data submitted by agencies all over the state and create camera-ready copy for more than 100 color illustrations. To meet a tight deadline, three Pubs artists worked steadily--incorporated two rounds of revisions and delivered polished copy by June 30, 1987. During the summer, we also provided custom drafting on 420 topographic maps, and in December, we revised all the illustrations for the state's environmental impact statement to the U.S. Department of Energy.

January through March 1988, the entire Publications staff participated in the grand finale. We produced eight reports (six Environmental Geology Notes, one special report, and one Circular)--all with the old technology.

New and improved products To produce the reports of the Illinois Mine Subsidence Research Program, the Survey created a special, limited series (table 1). The Pubs Unit supplied a technical writer/editor, who researched and wrote the overview, then coordinated production of four other reports. A Pubs artist designed, illustrated, and assembled the overview and a brochure to publicize the program.

The Illinois Petroleum series took off again in 1988. Two significant research reports were completed in FY88 and released in FY89. Yet Environmental Geology Notes continued to be the series of choice (table 1). EGN 128 was the first publication to benefit from the switch to computer techniques. The final product was a clear report turned out quickly for a tight deadline.

Table 1. Completed Publication Projects, May 1987 - June 1988*

	1984-85	*1985-86*	*1986-87*	*1987-88*
Circulars	4	2	4	3
Environmental Geology series	6	3	6	9
Illinois Mineral series	2	2	2	4
Illinois Petroleum series	1	1	0	3
Illinois Mine Subsidence Research Program (limited series)		-	-	5
Educational Extension Field Trip Guides	2	4	4	6
Reprints of outside publications	11	14	16	22
Contract/Grant Reports	3	5	3	1
Guidebook series	3	0	3	0
Cooperative Groundwater Reports	0	1	0	0
Illinois Scientific Survey Joint Reports	1	0	0	0
Abstracts	35	11	6	5
Papers, articles, published speeches	37	25	24	36
Plates (>8 1/2 by 11 inch)	16	3	3	3
Brochures, fliers, handouts, announcements	3	4	13	19
Posters--scientific presentations	7	15	30	29
Posters and displays--public relations	-	-	-	17
Special & administrative, including SSC	16	36	16	20
Geonews	-	-	3	3
Totals	*145*	*126*	*136*	*185*

* 1984-87 are each 12-month reporting periods; 1987-88 is 14 months.

Table 2. Graphics, Typographics, Photographics

Illustrations	*1985-86*	*1986-87*	*1987-88*
Miscellaneous maps, cross sections, diagrams (including sag basin graphics)	913	1,030	1,321
Graphics for ISGS publications only	258	458	439
Graphics for SSC projects	-	-	554
Totals	*1,171*	*1,488*	*2,314*
Plates (larger than 8 1/2 x 11 in.)	3	6	3
*Typesetting (number of pages)**			
Slides, text, tables, forms, charts, ads	1,817	2,157	1,950
Photography			
Photos taken for staff	1,283	1,134	1,387
2 x 2 inch slides: color	3,724	4,247	5,562
duplicate	1,991	2,514	3,105
PMT prints developed for staff	4,622	5,721	6,038
Screened PMTs for staff	437	522	583
Prints made	3,987	4,102	5,469

* Number of typesetting pages reflects lack of typographer for 2 months.

Continuing trends Poster presentations expanded from the scientific into the public relations field. Last year's output of 30 posters increased this year to 46 exhibits. Production of other PR items (brochures, announcements) increased steadily--with no negative impact on the production of scientific materials. Abstracts (1-page each) dropped from 35 in 1984-85 to five this past period, while papers rose again to their 1984-85 level (table 1).

Graphics production leaped upward again (table 2). Although demand for large maps has fallen from a high of 16 in 1984-85 to three in 1987-88, production of page-size illustrations has risen 25 percent each of the last 2 years (comparing 12-month periods only): the 1987-88 total nearly doubles the 1985-86 output.

Resource Capacity In 1988, the Pubs Unit not only gained new technology but also talented new staff--two editor/writers, an artist, and a typographer. With the retirement of our scientific



Anne Latimer *(left)* and Joan Stolz *(right)*, technical editors and writers, joined the Pubs Unit in midwinter 1987-88. Both work half time.

photographer, after 35 years of fine service to the Survey, the Unit is a compact team of one fulltime editor, two halftime editors, three artists, two part-time student draftsmen, one typographer, and one coordinator. Now the search is on for a new photographer.

Output ISGS publications for the 14-month period of May 1987 through June 1988 include :

• **Circular Series** comprehensive reports and reference works representing completion of a major phase of geologic research, a critical development in stratigraphy, or a substantive and enduring compilation of data.

C 541 *A Study of Trench Covers to Minimize Infiltration at Waste Disposal Sites: Final Report.* 1988. K. Cartwright, T. H. Larson, B. L. Herzog, T. M. Johnson, K. A. Albrecht, D. L. Mof- fett, D. A. Keefer, C. J. Stohr. 92 pages, 89 figures. [completed but not authorized to print]

C 542 *Stack-Unit Mapping of Geologic Materials in Illinois to a Depth of 15 Meters.* R. C. Berg and J. P. Kempton. 23 pages, 9 figures, 4 plates. [produced twice]

C 543 *Regional Geology of the Tiskilwa Till Member, Wedron Formation, Northeastern Illinois.* S. S. Wickham, W. H. Johnson, and H. D. Glass. 35 pages, 21 figures, 4 tables.

C 544 *The Illinois Basin--A Tidally and Tectonically Influenced Ramp During Mid-Chesterian Time.* 1988. Janis D. Treworgy. 20 pages, 12 figures.

• **Environmental Geology Series** timely reports of significant advances or pivotal discoveries in basic and applied environmental geological research.

EGN 120 *Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois: Results of the Spring 1985 Test Drilling Program.* 1987. J. P. Kempton, R. A. Bauer, B. B. Curry, W. G. Dixon, Jr., A. M. Graese, P. C. Reed, and R. C. Vaiden. 88 pages, 45 figures, 25 tables.

EGN 121 *Inventory of Lake Michigan Research Projects, 1984-1987.* 1987. N. P. Holm. 424 pages.

EGN 122 *Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois: Results of the 1986 Test Drilling Program.* 1988. B. B. Curry, A. M. Graese, M. J. Hasek, R. C. Vaiden, R. A. Bauer, D. A. Schumacher, K. A. Norton, and W. G. Dixon, Jr. 108 pages, 58 figures, 37 tables.

EGN 123 *Geological-Geotechnical Studies for Siting the Superconducting Super Collider In Illinois: Regional Summary.* A. M. Graese, R. A. Bauer, B. B. Curry, R. C. Vaiden, W. G. Dixon, Jr., and J. P. Kempton. 100 pages, 53 figures, 17 tables.

EGN 124 *Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois: Results of Drilling Large-Diameter Test Holes in 1986.* 1988. R. C. Vaiden, M. J. Hasek, C. R. Gendron, B. B. Curry, A. M. Graese, and R. A. Bauer. 58 pages, 17 figures, 11 tables.

EGN 125 *Disposal Alternatives for Material to be Excavated from the Proposed Site of the Superconducting Super Collider in Illinois.* 1988. L. M. Curran, S. B. Bhagwat, and C. A. Hindman. 17 pages, 5 figures, 5 tables. [produced twice]

EGN 126 *Potential Impact of Material to be Excavated from the Illinois SSC Tunnel on Surface Water and Groundwater Resources.* 1988. I. G. Krapac, W. R. Roy, R. A. Griffin, and T. Belssel. 19 pages, 2 figures, 5 tables.

EGN 127 *Natural Background Radiation in the Proposed Illinois SSC Siting Area.* 1988. R. H. Gilkeson, R. A. Cahill, and C. R. Gendron. 47 pages, 22 figures, 9 tables.

EGN 128 *Preliminary Sidescan-Sonar Investigation of Shore-Defense Structures along Chicago's Northside Lake Front: Wilson Avenue Groin to Ohio Street Beach.* 1988. M. J. Chrzastowski (ISGS) and J. S. Schlee (USGS). 32 pages, 14 figures, 3 tables.

Special Report *Geotechnical Summary to the Proposal to Site the Superconducting Super Collider in Illinois.* 1988. Harza Engineering Company with assistance of ISGS. 100 pages, 32 figures.

• **Illinois Mineral Series** reports of significant advances in basic and applied research in the area of mineral resources, or compilations of mineral economic data.

IMN 96 *Directory of Illinois Mineral Producers, 1986-1987.* 1987. I. E. Samson and John M. Masters. 151 pages.

IMN 97 The Future of Illinois Basin Coal: 1994 and Beyond. 1987. S. B. Bhagwat. 26 p.

IMN 98 *Subsurface Geochemical Investigation in Western and Southern Illinois: A Pilot Study.* 1987. R. L. Erickson, M. S. Erickson, and B. Chazin (USGS); J. W. Baxter, J. M. Masters, and J. J. Eidel (ISGS). 45 pages, 17 figures, 3 tables.

IMN 99 *Illinois Mineral Industry in Illinois and Review of Preliminary Mineral Production Data for 1986.* 1988. I. E. Samson. 45 pages, 12 figures, 25 tables.

• **Illinois Petroleum Series** reports of essential data on fuels exploration and research.

IP 128 *Petroleum Industry in Illinois, 1985. Part I: Oil and Gas Developments. Part II: Waterflood Operations.* 1987. J. Van Den Berg and J. R. Elyn. 140 pages, 2 figures, 15 tables.

IP 129 *Hydrocarbon Accumulation in a Paleovalley at Mississippian-Pennsylvanian Unconformity near Hardinville, Crawford County, Illinois: A Model Paleomorphic Trap.* 1988. R. H. Howard and S. T. Whitaker. 26 pages, 18 figures, 1 table. (complete, in press)

IP 130 *Silurian Pinnacle Reef Distribution in Illinois: Model for Hydrocarbon Exploration.* 1988. S. T. Whitaker. 32 pages, 21 figures, 1 table, 2 plates. (complete, in press)

• **Illinois Mine Subsidence Research Program Series** special reports--scientific and public information--designed to present all aspects of the IMSRP for the duration of the program.

IMSRP I *Crops and Coal: Illinois Mine Subsidence Research Program.* 1988. IMSRP staff with Joan Stolz. 18 pages, 37 figures and photos.

IMSRP II *Laboratory Characterization of Immediate Floor Strata Associated with Coal Seams in Illinois.* 1988. Y. P. Chugh (SIU at Carbondale). 112 pages.

IMSRP III *In Situ Strength Characteristics of Coal Mine Floor Strata in Illinois.* 1988. Y. P. Chugh (SIU at Carbondale). 160 pages.

IMSRP IV *High-Extraction Coal Mining in Illinois: Effects on Crop Production, 1985-1987.* R. G. Darmody, I. J. Jansen, S. G. Carmer, and J. S. Steiner (UI at Urbana-Champaign). 179 pages, 2 figures, 22 tables.

IMSRP V *Bibliography of Subsidence-Related Literature.* 1988. B. A. Trent, R. A. Bauer, and P. B. DuMontelle. 190 pages.

• **Educational Extension Geological Field Trip Guides**

1987-A *Tunnel Hill, Jackson County.* April 1987. D. L. Reinertsen.

1987-B *Dallas City, Hancock County.* May 1987. D. L. Reinertsen.
1987-C *Park Ridge--Northshore Area, Cook County.* October 1987. D. L. Reinertsen.
1987-D *Pinckneyville Area, Perry County.* November 1987. D. L. Reinertsen.
1988-A *Shawneetown Area, Gallatin County.* April 1988. D. L. Reinertsen.
1988-B *Canton Area, Fulton County.* May 1988. D. L. Reinertsen.

• Contract/Grant Reports

HWRIC *Statewide Landfill Inventory Update.* 1987. E. Mehnert and D. A. Keefer. 29 pages, 12 figures, 6 tables.

• Reprints of Papers Published in Journals or Proceedings

1987 reprints *1987C, Geographic Information Systems: A Computer Technology for the Coal Industry.* C. G. Treworgy and M. H. Bargh. • 1987D, *Structural and Depositional History of the Pennsylvanian System in Illinois.* C. B. Trask and J. E. Palmer. • 1987E, *Structure and Dynamics of a Pennsylvanian-Age Lepidodendron Forest: Colonizers of a Disturbed Swamp Habitat in the Herrin (No. 6) Coal of Illinois.* W. A. DiMichele and P. J. DeMaris.• 1987F, *Contact Microradiography of Conodont Assemblages.* R. D. Norby and M. J. Avcin. • 1987G, *Thrust Faults in Southern Illinois Basin--Result of Contemporary Stress.* W. J. Nelson and R. A. Bauer. • 1987H, *The Architecture and Function of Carboniferous Polygnathacean Conodont Apparatuses.* R. J. Aldridge, N. P. Smith, R. D. Norby, and D.E.G. Briggs. • 1987I, (1) *Carbon Monoxide-Ethanol Desulfurization of Coal: A Preliminary Economic Overview.* L. Wu, R. H. Shiley, R. L. Warren, R. E. Hughes, S. B. Bhagwat, C. C. Hinckley, and T. Wiltowski. (2) *The Carbon Monoxide/Ethanol Desulfurization of High Sulfur Coal--A Technical Overview.* R. L. Warren, R. H. Shiley, L. Wu, R. E. Hughes, K. Redding, C. C. Hinckley, and T. Wiltowski. • 1987J, *Sedimentological Characteristics and Genesis of Basal Tills at Wedron, Illinois.* A. K. Hansel, W. H. Johnson, and B. J. Socha. • 1987K, Analysis of Coal Surface Mining Equipment in Illinois. S. B. Bhagwat. • 1987L, *Creation of a Satellite Image Map of Illinois: A Case Study of Technology Transfer and Linkage.* R. E. Dahlberg, D. E. Luman, and C. J. Stohr. • 1987M, *Conversion of Inorganic Sulfides to Magnetic Pyrrhotite During Thermal Coal Desulfurization.* K. C. Hackley, C. L. Liu, and D. D. Coleman. • 1987N, *Laboratory Experiments to Evaluate the Removal of Ash, Sodium, Chlorine, and Sulfur from Three Selected Samples of Illinois Coal by Concentrating Table, Jig, and Froth Flotation Techniques.* I. Demir, R. B. Winston, and C.-L. Chou. • 1987O, *Remote Sensing Investigations at a Hazardous-Waste Landfill.* C. J. Stohr, W. J. Su, P. B. DuMontelle, and R. A. Griffin. • 1987P, *Coal Research at the Illinois State Geological Survey.* M. W. Leighton. • 1987Q, *A Satellite Image Mosaic of Illinois.* R. E. Dahlberg, D. E. Luman, A. Warren, and C. J. Stohr. • 1987R, Using Stable Isotopes to Monitor Forms of Sulfur During Desulfurization Processes: A Quick Screening Method. C.-L. Chou, K. C. Hackley, D. D. Coleman, and C. W. Kruse. • 1987S, *Valmeyer Anticline of Monroe County, Illinois.* R. D. Norby. • 1987T, *The Cache Valley of Southern Illinois.* J. M. Masters and D. L. Reinertsen. • 1987U, *Economics of the Coal Industry East of the Mississippi, 1973-1982.* S. B. Bhagwat.

1988 reprints *Ice Marginal Sedimentation in a Late Wisconsinan End Moraine Complex, Northeastern Illinois, USA.* A. K. Hansel. • 1988B, *Geologic Applications of a Geographic Information System: Development of a Coal Mine Information Database in Illinois. R. J. Krumm, L. R. Smith, R. R. Pool, and E. D. McKay. • 1988C, Principles and Applications of Clay Mineral Composition in Quaternary Stratigraphy: Examples from Illinois, USA.* H. D. Glass and M. M. Killey.

• Special Publications

ISGS Geonews Fall 1987, Winter 1988, Spring 1988 [Summer 1988 counted next year]

SSC projects (1) camera-ready production of 104 maps for the Illinois Proposal for Siting the Superconducting Super Collider in Illinois (supplied to Illinois Institute of Technology's Research

Institute); (2) draft rings and other features on 35 sets of 12 quadrangles--a total of 240 maps; (3) modification of all proposal maps for the Environmental Impact Statement prepared by Harza Engineering.

AAPG — Petroleum Series: *Interior Cratonic Sag Basins.* About 150 of the total 360 figures were produced during 1987-88.

Geologic map — *Stack-Unit Map of Southern Illinois.* R. C. Berg and J. P. Kempton.

Brochures, booklet — Educational Extension, CRSC, Computer Research, Public Information Unit, GIS short course, Satellite Image Map booklet for students, and other items.

LIBRARY/MAP ROOM

The Library/Map Room continued to provide a wide range of services to Survey staff. Journals, bibliographies, acquisitions lists, and other materials were routed to notify staff of work being done in their fields. The librarians verified and completed citations; prepared bibliographies on requested topics, conducted online literature searches; located articles, reports, and books; borrowed materials on interlibrary loan; and instructed staff in the use of the Library/Map Room.
A new journal routing program was begun in June 1987 using an in-house software program adapted to meet Survey needs. Records can now be kept of journals being routed, thus providing much-needed inventory control. Staff identify titles for which they wish to see tables of contents or which they wish to have routed to them. Journals are held in the library for one month to give researchers an opportunity to see current titles before they are routed.

A reference collection bibliography was begun. A short list of highlighted titles accompanies each acquisitions list. After more have been highlighted, a reference pamphlet for staff awareness will be produced.

Catalog cards are now being produced on our computer and printed in the library. Formats have been developed for map and manuscript cards as well as regular catalog cards. Card preparation time has been reduced 30 percent even though cards are now being printed in the library. The time lag between entering information and filing cards in the catalog has also been reduced.

The project to update Bulletin 92 continues. More than 2,000 items have been entered. Nearly 50 percent of the Survey's publications have been indexed and are currently being entered.

The library remains in an overall no-growth position because of seriously limited space. This year, the book and reference areas were weeded to provide for the anticipated growth over the next 3 years. The need for additional space in the state section and portions of the U.S. and journal sections is becoming critical.

The Map Room continues to be used as a room for small meetings. This past year, 114 meetings were held there.

TECHNICAL DESIGN, OPERATIONS AND MAINTENANCE

The Technical Design, Operations and Maintenance Shop provides special services to the Survey that would otherwise have to be handled through contractual services or the University of Illinois. Survey shop personnel install and maintain the air conditioners; repair, install, maintain, and move office/laboratory furniture and fixtures; unclog and repair drains; otherwise, care for most parts of Survey laboratories and offices that are considered departmental responsibilities.



Oscar Richter *(bottom left)* welds a base frame for a ball trailer-mounted mobile drill rig *(top)* that will be transferred to a 1988 Ford truck.

Shop personnel provide custom fabrication and repairs to laboratory, field, and scientific apparatus, office equipment, and furniture. Among the more noteworthy jobs during the reporting period were the following:

- rearranged upstairs storage area of garage; installed walls, doors, and air conditioning and painted to provide a clean, quiet environment for our electronics work area;
- rewired total upstairs area of the shop with more circuits and installed new lighting;
- enclosed a shop office with walls and a door, and installed air conditioning;
- installed a large exhaust fan and lights in car wash bay of garage to create an area for spray-painting desks, file cabinets, and other items;
- participated in planning and constructing the Clay Hydrology Laboratory Building;
- designed and engineered five sets of stairs used in Clay Liner Building;
- built and helped install prefab concrete forms for the clay-hydrology water-liner walls;
- built and installed transducer stations around the perimeter of the concrete walls in the clay hydrology liner;
- assisted in building 14 work stations suspended above the water liner in the Clay Hydrology Building;
- constructed instrument panel for clay liner project;
- assembled new Zodiac boat; checked trailer and lake-tested boat and motors;
- fabricated aluminum erosion grid;
- constructed erosion-measuring instrument;
- built several printer stands and sound-deadening covers;
- coordinated removal of walls and installation of door in rooms 31, 17, and 31A;

- removed lab benches from room 31 to accommodate wall removal;
- built rolling shelving unit for county maps;
- assisted in Applied Lab 203 renovations;
- built computer tables for the offices of the Chief, Human Resource, Administrative Group, and Graphics;
- purchased a new metal inert gas welder for shop and arranged for training sessions;
- revamped hoods in room 338;
- built rolling stand for lamination machine;
- designed and fabricated day boxes for transportation of explosives and caps used in seismograph work.

A total of 237 repair, fabrication, moving, maintenance, and other jobs were completed for internal work orders during this reporting period. This number does not include many other jobs done by verbal requests, notes, and regular maintenance procedures that are interspersed with the more elaborate shop work.

Electronics Shop

The electronics shop provides support to all groups in the Survey in electrical and electronic repair, maintenance, and installation. This past year, 100 internal work order requests for services were processed.

We took care of electrical site preparation for the new Core Flow equipment installed in room 31, electrical updating for the lab in room 334, and four new air conditioning installations. We provided RS-232 computer communications lines for our Publications and Computer Services units. We also installed lines for NBI Word Processor and PC users. We handled requests for additional telephones, relocation of phones, and problems with the Survey's phone equipment.

Joe Kaczanowski serves on the Computer Committee for the Administrative Group and is presently on the subcommittee for investigating networking and electronic mail possibilities.

A wide variety of electrical and electronic equipment is troubleshot and repaired by the electronics shop. Especially valuable is the repairing of field equipment for quick turn-around to field use and maintaining old equipment for research use. These efforts save the Survey thousands of dollars per year while providing invaluable services to support scientific research.

Automotive

In automotive, six vehicles were acquired during this reporting period: a 1987 Chevrolet station wagon to replace car number 3 (a 1980 Ford station wagon) and a 1987 Chevrolet carryall to replace number 9 (a 1980 GMC carryall). These two vehicles were received in the spring of 1987. In the spring of 1988, a 1988 Ford Tempo replaced number 5, a 1980 4-door Dodge Aspen. A 1988 GMC carryall replaced number 13, a 1979 GMC carryall. A 1988 Chevrolet carryall was purchased on the Argonne contract as an addition to the fleet (number 22). Another addition to the fleet was a 1988 2.5-ton Ford cab and chassis for installation of the B30S Mobile drill rig. The total number of vehicles in our fleet is now 23.

Applied Research Lab Shop

This shop provides repair, modification, and maintenance of equipment and some design assistance for technical staff located in the Applied Research Laboratory. The ARL staff conducts most of the chemical and minerals engineering studies conducted by the ISGS on coal and carries out a major portion of the coal analyses. Most of the projects are funded by contracts with CRSC.

EDUCATIONAL EXTENSION

The Educational Extension Unit provides information and materials on the state's geology, mineral resources, and landscape to elementary, high school, and college teachers, students, and the general public. The staff also presents slide-illustrated talks on Survey research and service to teacher workshops, high school science classes, clubs, and citizen groups throughout the state.

Geological Science Field Trips *Reinertsen et al.* Although designed to furnish teachers with background materials for classroom use, the four Geological Science Field Trips held each year are popular events for the general public as well. A guide leaflet is furnished to the participants. Additional guide leaflets from more than 80 previously held field trips are maintained on permanent file so that teachers and others may obtain them for later use. During this report period, more than 31 of these older guide leaflets were distributed each month.

The five field trips and their attendance for this report period were: Dallas City, April 16, 1987, 122 participants; Park Ridge-Northshore, October 3, 1987, 93; Pinckneyville, November 7, 1987, 107; Shawneetown, April 16, 1988, 145; and Canton, May 21, 1988, 125.

Distribution of Information *Carlisle and Reinertsen* During the past year, the Educational Extension staff responded to more than 700 mail inquiries by either writing letters or sending publications. More than 275 long-distance telephone inquiries also were answered, and more than 110 visitors were provided with information. The Educational Extension staff provided identifications for 43 samples submitted. Educational Series booklets mailed during the year totaled 1,697 copies. During this report period, 87 sets of topographic maps were distributed and 283 separate copies of the booklet, "Guide to the Use of Illinois Topographic Maps," were sent out. Requests for 437 copies of James A. Bier's "Landforms of Illinois" map were filled. More than 1,000 copies of the Satellite Map of Illinois (scale 1:500,000) and more than 4,900 copies of the Satellite Map of Northeastern Illinois (scale 1:200,000) were distributed since the last annual board report. The large number of the latter map is from distribution at SSC meetings.

Rock and Mineral Sets *Zelinsky, John Klitzing, McKinney, and Carlisle* The free set of 35 labeled rocks, minerals and fossils distributed to Illinois schools, Scout councils, and other educational groups is designed primarily for classroom display and as an aid in identifying unknowns brought in by students. The sets are distributed at the rate of one per school or one for each 500 students enrolled. During this reporting period, 245 complete rock and mineral sets and 35 orders for replacement specimens were distributed to Illinois institutions. In addition, 167 coal ball slices were sent to Illinois schools.

Educational Resources *Reinertsen and Carlisle* A new edition of the Educational Resources listing was compiled by the Educational Extension staff during the year and was distributed to all the nearly 7,500 schools in Illinois. The list includes the educational series, field trip guide leaflets, publications produced specifically for teachers, and publications in the Geological Survey's regular scientific series considered useful as background resource materials for teachers.

Educational Exhibits *Reinertsen* Displays about the geology and mineral resources of the state and the research and service activities of the ISGS were transported, set up and staffed by the Educational Unit at the following events during the year: the Illinois Science Teachers Association, October 16-17, Peoria; and the Engineering Open House, March 4-5, 1988, UIUC.

Lectures *Reinertsen* Lectures on the geology and origin of coal and Illinois coal resources were presented for teacher workshops at Clinton (July 14), Flossmoor (July 27), and Carterville (August 11). He also presented workshops on the Satellite Image Maps at the Illinois Science Teachers Association meeting (Peoria, October 16) and the Illinois Drafting Educators Association meeting (Galesburg, November 13). A workshop on the use of Illinois topographic maps was also held for each of the previously mentioned organizations. A slide-illustrated lecture, "The Ice Age in Illinois," was presented at a public assembly at the Illinois State Museum (Springfield, January 16).

Quaternary History of the Illinois-Michigan National Heritage Corridor *Hansel, Smith, and Stecyk* The staff provided text and concept for the color brochure, "Ice Age Geology of the Illinois and Michigan Canal National Heritage Corridor," which was printed and is being distributed by the National Park Service.

Other Activities *Reinertsen* Educational Extension's extensive collection of color slides came to the rescue several times during the year for scientists seeking good field illustrations. Reinertsen continues to represent the Director on the Statewide Advisory Board on Conservation Education of the Illinois State Board of Education and is one of the Survey's representatives on the Groundwater Protection Education Subcommittee.

GEOLOGICAL RECORDS UNIT

The Geological Records Unit is the repository for drilling records in Illinois, including oil and gas wells, water wells, engineering borings, and miscellaneous test holes. This database has long been of value to the oil industry, coal industry, hydrogeologists, engineers, land-use planners, academic institutions, land owners, general public, and staff.

On February 1, 1988, the Geological Records Unit was functionally divided into three working groups--Pending File Task Force, Records (oil and water), and Statistics. The ISGS Geological Samples Library Superintendent became Acting Unit Head of GRU and Leader of the Pending File Task Force. The primary function of this reorganization was to put a task force in place to transfer into permanent files some 6,406 pending files with summary sheets, at a rate of 670 per month, and meet a project deadline of December 1988. A task force consisting of six members working full-time was created. The task force has been moving these records at an average of 889 per month and will complete the project before the December target date. The table below summarizes the progress to date by the Pending File Task Force.

	Jan.	Feb.	Mar.	Apr.	May	Jun.
Jan. 1, 1988 backlog	6,810	6,406	5,697	4,875	4,030	3,000
No. of completed files removed	404	709	822	832	1,030	1,052

During the past reporting period four computer milestones were reached by the Geological Records Unit; implementation of the computerized daily mail program; generation of the monthly noncompliant operators list for the Department of Mines and Minerals; computer tracking of visitors to GRU; a new computerized database entry for water well permits.

On January 1, 1988, authority to issue permits for potable water wells was transferred to the Illinois Department of Public Health from the Department of Mines and Minerals. This transfer has created a new permit process, requiring a major change in the Unit's handling of water well permits. A new personal computer and accessories were purchased and a database program modified for data entry. The monthly water-well permit list is generated from this program.

GRU staff assist visitors and staff with requests for information regarding drillhole records on file. The staff also receives and fills orders for copies of logs and other well data. Use of the well records by staff has increased and use by visitors decreased slightly. Orders taken also decreased (2,710 compared with 3,157 the previous year); therefore, revenues generated from the copy service decreased.

Annual Acquisitions

Oil well permits issued (2,422) by the Department of Mines and Minerals increased by 636 from last year's low of 1,826. Data acquisition for the reporting period declined. The Department of

Mines and Minerals' program to contact operators for drilling information concentrates on current records due and does not address wells permitted before January 1, 1987. Oil well plugging affidavits increased during the reporting period. Of the 3,582 affidavits received, 2,259 were for oil wells (compared with 2,569 for oil and water the previous year). Total new logs received (8,532) decreased by 50 percent. The following table summarizes GRU activity.

Data acquisition

Permits/affidavits	1986-87	1987-88
Oil permits	1,826	2,462
Oil permit corrections	168	190
Water permits	7,002	11,824
Plugging affidavits--oil	2,569	2,259
--water		1,323
Logs	**1986-87**	**1987-88**
Electric logs	3,145	1,003
Micro logs	478	212
Radioactivity logs	3,276	1,485
Miscellaneous geophysical logs	328	62
Total geophysical logs	7,247	2,762
Drillers logs	418	241
Drilling time logs	567	213
Company sample and core studies	311	44
Geologic tops	323	79
General data (completion data)	3,108	1,958
Water well & test hole logs	4,026	5,914
Miscellaneous	1,189	83
Total new logs received	17,189	8,532
Collections	**1987-88**	**Total**
Processed drillhole records	9,355	286,412
Books of processed drillhole record	25	776
Skeleton logs (records before 1920)		17,920
Books of skeleton logs		40
Books of confidential logs		15
Books of out-of-state logs		14
Books of misc. drillhole records		9
Geophysical logs	2,762	121,667
Coal pluggings	1,508	20,537
Service activities	**1986-87**	**1987-88**
Visitor days		1,511
Files used by public & staff		73,726
Phone calls	2,598	3,516
Total orders processed	3,157	2,710

GEOLOGICAL SAMPLES LIBRARY

The ISGS Geological Samples Library Unit manages one of the largest physical collections of geological samples in the United States. The Samples Library staff receives, processes for storage, and archives these important collections as mandated by Illinois Statute (chapter 96,

Natural Resources Conservation of Oil and Gas). The Geological Survey began collecting these samples in the early 1900s when the USGS provided a series of drill cuttings to the State Geologist. Today, this unique repository houses cores and cuttings that represents billions of dollars invested in Illinois by petroleum and mining and engineering companies. The collection attracts users from across the country, encouraging potential investment in Illinois by both in-state and out-of-state companies and providing a database with which to address environmental and resources issues.

Visitors and staff members referred to our files 466 times (38 less than in 1987) and studied 938 sets of samples or core (150 more than 1987). Visitors to the Annex facility represent a wide range of geologic interests. Independent consultants and representatives of major oil companies, universities, and government agencies are typical visitors to the Samples Library. Of the 207 (80 less than 1987) visitors to the Samples Library, 14 percent were from out-of-state. The decline in visitors reflects the overall decrease in the nation's oil exploration effort.

Samples Library personnel assemble rock and mineral kits for distribution to Illinois schools. A 35-specimen set is designed to familiarize teachers and students with the rocks, minerals, and fossils of Illinois. This past year Samples Library staff assembled 245 specimen kits (134 more than previous year) and filled 35 orders to recondition sets already assigned to schools. The Samples Library houses the Survey's microfiche collection of well log information, and sells copies or assists visitors who wish to examine this collection of 79,677 microfiche (7,124 added).

Three projects were completed to make additional information regarding Samples Library collections available to visitors and staff. A catalog, "1986 Additions to the Geological Samples Library," was published by the Survey. This catalog is the first in a series of yearly updates on cores and well cuttings added to our collections. Samples Library staff also completed a card index file that lists information for 3,028 confidential cores. This card file located in the Geological Survey's Coal Section is a complete data set of confidential coal cores on file at the Annex facility. Information regarding 1,065 permeability plugs interfiled with the core collection was added to the core index card file in the Survey's Geological Records Unit. This file, which is open to staff and public, now lists information on all nonconfidential cores that are on file in the Samples Library.

Effective July 1, 1988, the Geological Survey will no longer be contracting for sample processing services from the Evansville Sample Cut in Indiana. Processing will be done within existing facilities at the Survey. Budget constraints necessitated this action. The Survey will be notifying the drilling industry that samples requested on permits should be delivered or shipped prepaid to the Illinois State Geological Survey.

Samples Acquisition

Cuttings Oil and water well cuttings added to the Geological Samples Library during the reporting period increased the total footage of cuttings to 741,702,387 feet.

During the past reporting period, the permanent file of the Samples Library acquired 358 sets of well sample cuttings, representing more than 838,360 feet of drilling. These samples are contained in 800 boxes and occupy an additional 9 linear feet of storage space. One hundred seventy-nine sets of sell cuttings were requested from permits issued last year, compared with 131 the previous year. The Samples Library files of 66,425 sets of well cuttings are stored in 101,472 boxes and utilize 1,409 linear feet in a 3,780-square foot area in the Samples Library.

Samples from an additional 63 oil and water wells await processing. At present, the interval between receipt and permanent processing is 4 months (an 8-month decrease). Additions to our permanent files consisted of 52 oil test sets from rotary drill wells washed, 60 washed sets purchased from the Evansville Sample Cut, 190 donated sets, dry processed, and 56 water wells. Sixty-three percent of the 179 sets of oil well cuttings requested were received last year.

Cores Rock cores from oil and mineral borings added to the Geological Samples Library during the reporting period increased the total footage of core to 920,580 feet. During the reporting period, 156 cores representing an initial 49,901 feet of drilling were collected, examined and processed into the permanent files. This year's additions represent an addition of 29 cores and 11,922 feet over last year's additions. The entire collection of 13,371 sets of core on permanent file is stored on steel racks in an area covering approximately 4,300 square feet of the Samples Library.

Other Sample Collections

During the past reporting period, 355 Pleistocene (P series) samples representing glacial materials were processed into the permanent files. The ISGS collection in this sample category now totals 24,097 individual samples. Some 3,500 additional insoluble residue samples, mostly composite samples, were also added to our collection. In cooperation with the Industrial Minerals and Metals Section, an additional 3,000 insoluble residue samples were split and prepared for analysis. The ISGS staff generates a large volume of research material. GSL staff receive, sort, and file these materials in the Staff Research Collections storage area of the Samples Library. More than 32,000 individual research samples are on file at the Annex.

The Geological Survey provides sample bags for the collection of well sample cuttings that are requested on permits issued by the state. During the past reporting period, the Samples Library supplied drillers and operators with 36,250 sample bags for requested well cuttings (17,300 more than previous year).

Honors

HONORS AND AWARDS

Robert A. Bauer, Associate Geological Engineer and Supervisor of the Rock Mechanics Laboratory was named the 1987 recipient of the Douglas R. Piteau Award by the Association of Engineering Geologists at its national meeting in Atlanta in October. Presented to members under 35 years of age, the award is for distinction through technical accomplishments, service to the Association, and service to the engineering geology profession. Mr. Bauer was nominated by the North-Central Section of AEG for outstanding achievements in the study of rock mechanics and its applications to problems of coal mine stability and mine subsidence.

Kristi Redding Brewer received an award for the outstanding scientific poster presentation at the National Corn Growers Association Corn Utilization Conference in June 1987 in St. Louis, Missouri. The poster described the use of ethanol for coal desulfurization.

Keros Cartwright was named the 1987-88 Birdsall Distinguished lecturer by the Hydrogeology Division of the Geological Society of America. In this capacity, he lectured at more than 15 universities in the United States, Canada, and Mexico during the academic year.

Charles Collinson received a plaque from the Edgewater (Chicago) Community Council for his contributions to the Council's lake-front design programs. The plaque was presented at a summary review meeting held at Loyola University of Chicago, September 14, 1987.

Paul B. DuMontelle, Robert A. Griffin, Christopher J. Stohr, and Wen-June Su received "The Autometric Award" for 1987 at the annual meeting of the Association of Engineering Geologists in St. Louis, March 16, 1988, for their paper "Remote sensing investigations at a hazardous waste landfill." The award, offered by Autometric, Inc., is presented to stimulate development and recognize achievement in the field of photographic interpretation through special acknowledgement of superior publications on the various aspects of imagery interpretation.

Steven W. Harrison, Contracts and Grants Officer, received a plaque from the U.S. Fish and Wildlife Service recognizing his 6 years of service as State-Federal Aid Coordinator for the Illinois Department of Conservation before he joined the ISGS.

Richard H. Howard was named "Petroleum Professional of the Year" by the Illinois Oil and Gas Association at their meeting, March 3, 1988 in Evansville, Indiana. According to Marshall E. Daniel who made the presentation, the award recognized Mr. Howard's "contributions to the success of dozens of others through his selfless dedication to the Survey and the oil industry in Illinois. He always finds time to assist visitors and co-workers.... His honesty, integrity, good humor, and knowledge of the Basin have helped many people throughout the years."

James C. Ploetz was elected a member of Gamma Theta Upsilon, the international honors society for geography, in April 1987.

Richard H. Shiley received the Illinois State Geological Survey's Distinguished Achievement Award on September 22, 1987. Recipients are nominated by the staff and selected by the Management Committee on the basis of "cumulative or annual achievement in any or all of the following areas: excellence in overall work performance; innovative, creative contributions to science and/or to the operating efficiency and effectiveness of the staff member's Unit, Section, Group or the Survey; achievements that bring significant benefit and/or recognition to the Survey; and contributions to the morale of the Survey." Mr. Shiley was recognized for his significant achievements in development of the carbon monoxide/ethanol coal desulfurization process.

Stephen T. Whitaker's paper "Silurian pinnacle reef distribution in Illinois: a model for hydrocarbon exploration" was honored as the "Best Poster Presentation" at the annual meeting of the Eastern Section, American Association of Petroleum Geologists, October 1987 in Columbus, Ohio.

Activity Measures

ACTIVITY MEASURES

All Illinois state agencies are required to provide activity measures as part of their annual budget presentations to the legislature. Selected activity measures also are included in the Governor's report on the Ilinois state budget. Internally, we use a wide range of activity measures to guage how effective we are at reaching the public with our information and services. The measures are also helpful indicators of where our research and service staff are applying their greatest energies, and to what degree we may need to adjust or reshape our program, budget or organization.

Although our records are kept throughout the year on such items as publications distributed or numbers of sponsored research projects, some of our activity measures are based on annualized calculations from samples counted during a representative 1 to 3 month period. In most cases, this limited sampling provides a sufficient level of accuracy.

Measures

Research Activities ISGS scientists reported 166 active state-funded research projects in progress during the year, 48 more projects than last year. Of these, 76 were in the area of Mineral Resources, 27 in Environmental Geology and 63 in General and Basic Research. The number of projects in the General and Basic Research area has nearly doubled in comparison to last year, and most of that increase occurred in the area of Computer Research and Service. The continued relatively small number of state-funded research projects in the area of Environmental Geology reflects in large part the fact that external support for this area of research is relatively easier to obtain than for many other areas of research that we do. Our scientists reported 99 active sponsored research projects for the year, of which 57 were in the area of Environmental Geology, 30 in Mineral Resources and 12 in General and Basic Research. During the year, our scientists submitted 121 proposals to outside agencies to seek funds for research activities.

To present our research information to the public and the scientific community, we published a combined total of 270 new articles, maps, reports and abstracts in our own publication series and in other forums such as refereed scientific journals, proceedings volumes, guidebooks and pamphlets. Were it not for the addition of a large number (80) of county coal mine directory maps, this number of new publications is approximately the same as last year's productivity. However, the Information and Technical Services Unit distributed a much larger number of publications this year than last. The ISGS sold 10,193 copies of its publications and distributed another 22,462 copies gratis. We also sold 2,984 copies of our own maps and distributed another 6,064 copies gratis; this totals 41,713 copies of our own publications, approximately 4 percent more than last year. In addition, we sold 20,885 copies of U.S. Geological Survey map products and distributed another 6,617 copies gratis.

Public, Government and Industry Services The accompanying table shows selected measures of our service provided during the year, distributed by program areas.

- ***Information Responses*** ISGS scientists hosted 6,134 visitors in their offices this year to exchange scientific information. They also sent out 2,394 letter responses to inquiries and and responded to more than 27,221 telephone requests for information. Included in this number is more than 10,322 telephone calls received by the Information office. In last year's annual report, the more than 44,000 telephone calls that passed through our old PBX switchboard were not included in the count of telephone activities for the entire Survey. Although the Information Office continues to route some phone calls to the scientists as needed, with the advent of the new telephone system at ISGS, many calls now reach the scientists directly. The number of vistors to the Survey declined by almost 726 below FY 1987 levels, about 12 percent. Virtually all of this decline is the result of a decline in the number of visitors to the Groundwater, Environmental Studies and Assessment, and Earth Hazards and Engineering Geology Units in the Environmental Geology research area. All told, the number of visitors reported by scientists in the

Environmental Geology area for FY 1988 decreased almost 59 percent from FY 1987 levels. At the same time, however, the number of reported telephone responses rose by almost 46 percent to almost 7,000 calls. About 1,105 visitors came to the Geological Records Unit this year, a decline of 26 percent below FY 1987. The unit responded to 2,813 telephone calls, a decrease of 37.5 percent below FY 1987. The Geological Samples Library hosted 145 external visitors this year and distributed 279 sample sets to those visitors, and 376 to staff members. The number of external visitors is almost exactly one-half the number who visited last year. The reduction in visitor activity in these two units, which primarily serve the oil and gas exploration and development industry, reflects the dismal economic conditions for that industry in Illinois during the past year.

• ***Identifications, Analyses, and Reports of Results*** To conduct various research and service projects during the year, ISGS scientists completed at least 20,444 technical and chemical analyses. This total includes chemical analyses performed on 4,897 samples of rocks, minerals soils and coals that involved 21,904 determinations of separate elemental concentrations or other chemical or physical properties. Other technical analyses included some 1,500 samples analyzed by x-ray diffraction to determine mineral content; 6,029 determinations of particle size or suspended sediment concentrations; 2,022 determinations of insoluble residue content of limestones and dolomites; 516 determinations of Rock-Eval values on 251 samples; 199 hand specimen identifications for visitors; 63 holes logged by geophysical methods, 161 cores and 138 sample sets described; and 167 electrical earth resistivity surveys and 227 shallow seismic survey lines completed. To report the results of these analyses, and for other purposes, ISGS scientists prepared 1,080 unpublished reports, memoranda and other responses, including 318 groundwater reports, 4 waste disposal site reports, 41 deep-well disposal reports, 20 high-volume well reports, 41 mine subsidence reports and 345 computer-plotted maps and diagrams. ISGS staff members, mainly in the Computer Reasearch and Services Section, wrote 707 computer programs, digitized 102 maps, and encoded, entered and verified data for 146 different projects.

Continuing Scientific/Educational Contributions Geological Survey staff members made 144 presentations of scientific papers and poster sessions at various meetings of learned and professional societies and participated 93 times in various conferences and field trips. Our scientists presented formal lectures, seminars and classes and coloquiums for colleges, high schools, elementary schools and other educational groups 45 times, assisted graduate students in various ways 337 times, and participated in or led 116 workshops and training courses during the year. Our scientists hold 91 offices or committee seats in scientific and educational societies and professional organizations, and reviewed 203 manuscripts for professional journals and other outside publications. The Educational Extension Unit distributed 289 Rock and Mineral sets, 28 partial sets to Illinois schools and responded to 714 other requests for educational materials of various kinds. A total of 470 people attended the 4 public field trips held this year by the Ed. Extension unit.

Public, Industry, Government Contributions Survey staff members presented some 96 popular talks to civic groups, scientific hobby groups and other organizations, gave some 315 press interviews (mostly in connection with the SSC), and presented testimony 39 times at hearings and public meetings of various governmental and non-governmental advisory panels, fact-finding committees, boards and other agencies. Some 28 of our scientists are themselves members of such panels. These numbers are all included in the total of 629 talks and public addresses listed in the folowing table.

Illinois State Geological Survey Selected Activity Measures 1987-88

	Mineral Resources	Environmental Geology	General and Basic Research	Admininstrative Services	Total
Reports/maps					
• published	140	49	16	6	211
• distributed					69,215
Unpublished reports, memos	158	515	42	734	1,449
Talks, posters, interviews	133	434	53	9	629
Workshops, classes and seminars	84	100	61	20	265
Visitors and office conferences	2,234	523	395	2,982	6,134
Telephone responses	6,843	6,924	1,352	12,102	27,221
Letter responses	784	1,000	256	354	2,394

Financial Report

FINANCIAL REPORT

Fiscal Year 1988

Appropriated Funds Of the appropriated FY88 funds totaling $5,884,500 (tables F-1 and F-2), the Illinois State Geological Survey expended all but $180,600. The unexpended funds remained in the Natural Resources Information Fund line item, which was purposely underspent in order to carry forward receipts for use in FY89. No lapse occurred in the GRF line items.

Allocated Funds Of the FY88 allocated funds totaling $532,600 (tables F-3, F-4, and F-5), the Illinois State Geological Survey expended all but $138,100. The balance of these funds were (1) used by other Divisions (LUMP $6,500), (2) rolled over into FY89 funds (Build Illinois $125,900), or (3) lapsed (Groundwater Protection $5,500). The small lapse of $5,500 was caused by the manner in which the line item appropriation was established making those funds unavailable for expenditure by the Geological Survey.

FINANCIAL REPORT

Table F1. FY88 Financial Statement for the Illinois State Geological Survey General Revenue Fund (July 1, 1987 through September 30, 1988)

Line item	Appropriation for FY88	Transfers	Vouchered to date	Outstanding obligations this date	Balance available for FY88
Personal Services	$4,529.0	$3.1	$4,532.1	$0.0	($0.0)
Personal Services - GeoMapping	85.9	0.0	85.9	0.0	0.0
Retirement Contributions	448.6	0.0	448.6	0.0	0.0
Social Security Contributions	5.1	0.1	5.2	0.0	(0.0)
Contractual Services	96.2	(15.8)	80.4	0.0	(0.0)
Topomapping	19.0	0.0	19.0	0.0	0.0
Travel	37.7	(0.9)	36.8	0.0	0.0
Commodities	70.0	15.0	85.0	0.0	0.0
Printing	34.2	(1.6)	32.6	0.0	0.0
Equipment	45.0	0.0	45.0	0.0	0.0
Computer Based Research	44.9	0.0	44.9	0.0	0.0
Telecommunications	54.2	(1.2)	53.0	0.0	0.0
Operations of Auto Equipment	34.2	1.3	35.5	0.0	0.0
GeoMapping - Other Expenses	24.8	0.0	24.8	0.0	0.0
TOTALS	$5,528.8	($0.0)	$5,528.8	$0.0	($0.0)

IDENR allocated $18.8 to the Survey from the Geographical Information System line.

Table F2. FY88 Financial Statement for the Illinois State Geological Survey Natural Resources Information Fund (July 1, 1987 through September 30, 1988)

Line item	Appropriation for FY88	Transfers	Vouchered to date	Outstanding obligations this date	Balance available for FY88
Lump Sum - Operating Expenses	$354.7	$0.0	$175.0	$0.0	$179.7
Refunds	1.0	0.0	0.1	0.0	0.9
TOTALS	$355.7	$0.0	$175.1	$0.0	$180.6

NRIF Revenue July 1, 1987 through June 30, 1988 was $132.4.

Table F3. FY88 Financial Statement for the Illinois State Geological Survey Lands Unsuitable for Mining Program (July 1, 1987 through September 30, 1988)

Line item	Appropriation for FY88	Transfers	Vouchered to date	Outstanding obligations this date	Balance available for FY88
Personal Services	$83.0	$0.0	$83.0	$0.0	$0.0
Social Security Contributions	0.0	0.0	0.1	0.0	(0.1)
Group Insurance	4.8	0.0	3.6	0.0	1.2
Contractual Services	31.0	0.0	25.6	0.0	5.4
Travel	4.0	0.0	4.9	0.0	(0.9)
Commodities	3.5	0.0	3.4	0.0	0.1
Computer Based Research	7.8	0.0	7.1	0.0	0.7
Telecommunications	1.3	0.0	1.0	0.0	0.3
Operations of Auto Equipment	0.0	0.0	0.0	0.0	0.0
TOTALS	$135.4	$0.0	$128.7	$0.0	$6.7

Table F4. FY88 Financial Statement for the Illinois State Geological Survey Groundwater Protection Act (July 1, 1987 through September 30, 1988)

Line item	Appropriation for FY88	Transfers	Vouchered to date	Outstanding obligations this date	Balance available for FY88
Personal Services	$60.9	$6.3*	$67.2	$0.0	($0.0)
Retirement Contributions	3.1	0.0	0.0	0.0	3.1
Social Security Contributions	4.3	(1.7)	0.3	0.0	2.3
Travel	4.0	0.0	3.9	0.0	0.1
TOTALS	$72.3	$4.6	$71.4	$0.0	$5.5

* IDENR allocated an additional $4.6.

Table F5. FY88 Financial Statement for the Illinois State Geological Survey Miscellaneous Funds (July 1, 1987 through September 30, 1988)

Line item	Appropriation for FY88	Transfers	Vouchered to date	Outstanding obligations this date	Balance available for FY88
Repair and Maintenance	$4.8	$0.0	$4.8	$0.0	$0.0
Build Illinois Equipment	268.3 *	0.0	142.4	109.0	16.9
Build Illinois Maintenance	51.8	(2.2) **	49.6	0.0	(0.0)
TOTALS	$324.9	($2.2)	$196.8	$109.0	$16.9

* $268.3 includes $173.9 reappropriated funds from FY87.

** IDENR reduced allocation by $2.2.

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October 1, 1988 Champaign, Illinois

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LINOIS STATE GEOLOGICAL SURVEY ANNUAL REPORT

y 1987–June 1988

ECOGNITION AND SERVICE

ILLINOIS STATE GEOLOGICAL SURVEY

ANNUAL REPORT FOR FISCAL YEAR 1988

Recognition and Service

HONORS AND AWARDS

Robert A. Bauer, Associate Geological Engineer and Supervisor of the Rock Mechanics Laboratory, was named the 1987 recipient of the Douglas R. Piteau Award by the Association of Engineering Geologists at its meeting in Atlanta in October. The award is presented to members under 35 years of age who have achieved distinction through technical accomplishments, service to the Association and service to the engineering geology profession. Mr. Bauer was nominated by the North-Central Section of AEG for outstanding achievements in the study of rock mechanics and its applications to problems of coal mine stability and mine subsidence.

Kristi Redding Brewer received an award for the outstanding scientific poster presentation at the National Corn Growers Association Corn Utilization Conference in June 1987 in St. Louis, MO. The poster described the use of ethanol for coal desulfurization.

Keros Cartwright was named the 1987-88 Birdsall Distinguished lecturer by the Hydrogeology Division of the Geological Society of America, and in this capacity he lectured at more than 15 universities in the United States, Canada, and Mexico during the academic year.

Charles Collinson received a plaque from the Edgewater (Chicago) Community Council for his contributions to the Council's lakefront design programs. The plaque was presented at a summary review meeting held at Loyola University of Chicago, September 14, 1987.

Paul B. DuMontelle, Robert A. Griffin, Christopher J. Stohr, and Wen-June Su received "The Autometric Award" for 1987 at the annual meeting of the Association of Engineering Geologists in St. Louis, March 16, 1988, for their paper "Remote sensing investigations at a hazardous waste landfill." The award, offered by Autometric, Inccorporated, is presented to stimulate development and recognize achievement in the field of photographic interpretation through special acknowledgement of superior publications on the various aspects of imagery interpretation.

Steven W. Harrison, Contracts and Grants Officer, received a plaque from the U.S. Fish and Wildlife Service recognizing his six years of service as State-Federal Aid Coordinator for the Illinois Department of Conservation before he joined the ISGS.

Richard H. Howard was named "Petroleum Professional of the Year" by the Illinois Oil and Gas Association at its meeting, March 3, 1988 in Evansville, IN. According to Marshall E. Daniel who made the presentation, the award recognized Mr. Howard's "contributions to the success of dozens of others through his selfless dedication to the Survey and the oil industry in Illinois. He is always able to find time to eagerly assist visitors and co-workers in whatever questions or problems they have."

James C. Ploetz was elected a member of Gamma Theta Upsilon, the international honors society for geography, in April 1987.

Richard H. Shiley received the Illinois State Geological Survey's Distinguished Achievement Award on September 22, 1987. Recipients are nominated by the staff and selected by the Management Committee on the basis of "cumulative or annual achievement in any or all of the following areas: excellence in overall work performance; innovative, creative contributions to science and/or to the operating efficiency and effectiveness of the staff member's Unit, Section, Group or the Survey; achievements, either within the staff member's area of expertise or in other areas, which bring significant benefit and/or recognition to the Survey; and contributions to the morale of the Survey..." Mr. Shiley was recognized for his significant achievements in the development of the carbon monoxide/ethanol coal desulfurization process.

Stephen T. Whitaker's paper "Silurian pinnacle reef distribution in Illinois: a model for hydrocarbon exploration" was honored as the "Best Poster Presentation" at the annual meeting of the Eastern Section, American Association of Petroleum Geologists, October 7-10, 1987 in Columbus, OH.

SCIENTIFIC AND EDUCATIONAL CONTRIBUTIONS

Papers/Abstracts Presented at Scientific Meetings

Karen A. Albrecht presented the paper "Performance monitoring of a compacted clay liner" at the annual spring meeting of the American Geophysical Union in Baltimore, MD, in May 1987.

Robert A. Bauer attended the 28th U.S. Symposium on Rock Mechanics held in Tucson, AZ, in July 1987, where he presented the paper "Effects of Valleys on Rock Strength."

James W. Baxter presented the paper "Possible underground mining of limestone and dolomite in central Illinois" at the 23rd Forum on the Geology of Industrial Minerals held at North Aurora, IL, May 19 - 23, 1987. He was general chairman of the meeting and led field trips on the "Industrial Minerals of Northeastern Illinois" covering the areas around Chicago, Oglesby, Ottawa, and Streator. **Randall E. Hughes and James Bradbury** [emeritus] were program co-chairmen for the meeting, and **Henry Ehrlinger and Jon Goodwin** were co-treasurers, asssisting Baxter, **John Masters and Don Mikulic** in leading three field trips and running the meeting. Dr. Baxter also coordinated a field conference June 15-17, 1987, around Elco, Olmstead, and the Fluorspar Mining District for Bruce Johnson of the U.S. Geological Survey and other members of the Paducah CUSMAP geological team from the Indiana, Kentucky, and Missouri Geological Surveys.

Chusak Chaven presented the paper "Determination of elemental sulfur in coal and pyrolyzed products by second derivative UV spectroscopy" at the Midwest Regional Meeting of the American Chemical Society, Loyola University of Chicago, June 10-12, 1987. At the Illinois Coal Development Board 5th Annual Contractors' Technical Meeting, July 28-30, 1987, Urbana, IL, he presented the paper "Forms of sulfur: A fractionation scheme for coal pyrolysis products."

Chen-Lin Chou presented the paper "Distribution of sodium, chlorine and sulfur in Illinois coals, removal by physical cleaning, and their behavior during combustion" at the Illinois Coal Development Board 5th Annual Contractor's Technical meeting, Urbana, IL, July 28-30, 1987. At the XI International Congress of Carboniferous Stratigraphy and Geology in Beijing, China, August 31 - September 4, 1987, he presented the paper "Geochemistry of bituminous coals of Pennsylvanian in the Illinois Basin USA." In Phoenix, AZ, at the national meeting of the Geological Society of America, October 26-29, 1987, he presented the paper "Isotopic composition of pyritic and organic sulfur in 20 lithotype samples from a single column of coal."

Melissa Chou presented the paper "Organic geochemistry of Anna and Energy Shale Members of the Carbondale Formation (Pennsylvanian), Illinois Basin" at the 1987 Eastern Oil Shale Symposium in Lexington, KY, November 18-20, 1987.

Michael J. Chrzastowski presented the paper "Examination of nearshore bathymetry and shore-defense structures along Chicago's northside lakefront" at the annual meeting of the North Central Section of the Geological Society of America in Akron, OH, April 21-22, 1988.

Dennis D. Coleman was invited to present the talk "Microbial methane in the shallow Paleozoic sediments and glacial deposits of Illinois" for the symposium "Origins of methane in the earth" sponsored by the Oil and Gas Division of the Geological Society of America at the Society's annual meeting in Phoenix, AZ, October 26-29, 1987.

Charles Collinson presented the paper "Lake Michigan water levels, geologic data, and public policy in Illinois" and participated in a panel discussion at the annual meeting of the North-Central Section of the Geological Society of America, April 22, 1988, at Akron, OH.

Joan E. Crockett presented the paper "Source rock screening studies of the Ordovician Maquoketa Shale in western Illinois" at the meeting of the Eastern Section of the American Association of Petroleum Geologists at Columbus, OH, October 8, 1987.

B. Brandon Curry presented the paper "Radiocarbon and pedogenic evidence in northeastern Illinois for absence of glacier activity from the Sangamonian to the Wisconsinan" in a poster session at the Geological Society of America Penrose Conference on "Environmental Interpretations of Paleosols" at Warm Springs, OR, September 11-17, 1987. At the annual meeting of the North-Central Section of the Geological Society of America in Akron, OH, on September 22, 1987, he presented the paper "Additional evidence for absence of Altonian glaciation in Illinois." At the April 26, 1988, meeting of the North-Central Section of the Association of Engineering Geologists in Chicago, Mr. Curry discussed the "Stratigraphy and engineering geology of glacial drift in northeastern Illinois."

Joseph A. DeBarr and David L. Moran attended the Sixteenth Annual Meeting of the North American Thermal Analysis Society at Washington, DC, September 27-30, 1987. At the meeting, Mr. DeBarr presented the paper "Thermogravimetry-combustion behavior of coal-derived solid fuels: I. Effect of experimental parameters on burning profiles" and Mr. Moran presented the paper "Thermogravimetric characterization of cyclone and bottom ashes from fluidized bed combustion studies of coal derived solid fuels."

Philip J. DeMaris presented the paper "The effects of advanced physical coal cleaning on mineral matter and ash composition and its relationship to boiler slagging and fouling potential" at the 195th national meeting of the American Chemical Society in Toronto, Ontario, Canada, in June 1988. He and **Henry P. Ehrlinger III** jointly presented the paper "The ISGS aggregate flotation (AF) fine coal cleaning process" at the Illinois Coal Development Board 5th Annual Contractors' Technical Meeting, July 28-30, 1987, Urbana, IL.

Ilham Demir presented the paper "Laboratory experiments to evaluate the removal of ash, sodium, chlorine, and sulfur from three selected samples of Illinois coal by concentrating table, jig and froth flotation techniques" at the Second International Conference on Processing and Utilization of High Sulfur Coals in Carbondale, IL, September 27 - October 1, 1987.

Joseph A. Devera presented the paper "Middle Devonian paleogeography and tectonic relationships east of the Ozark Dome, southeastern Missouri, southwestern Illinois, southwestern Indiana and western Kentucky" at the Second International Symposium on the Devonian System sponsored by the Canadian Society of Petroleum Geologists, Calgary, Canada, August 1987.

J.James Eidel presented the paper "Status of Illinois Basin ultradeep drillhole project" in a poster session at the annual meeting of the Geological Society of America in Phoenix, AZ, October 26-29, 1987.

Keith C. Hackley presented the paper "Location of isotopically characterized coal samples" at the Fifth Annual Contractors' Technical Meeting of the Illinois Coal Development Board held in Urbana, July 28-30, 1987. Later in the year he attended the Second International Conference on Processing and Utilization of High Sulfur Coals in Carbondale, where he presented the paper "Conversion of inorganic sulfides to magnetic pyrrhotite during thermal coal desulfurization." He also attended the annual meeting of the Geological Society of America in Phoenix, AZ, October 26-29, 1987, where he presented the paper "Isotopic compositions of pyritic and organic sulfur in 20 lithotype samples from a single column of coal."

Ardith K. Hansel presented a poster session on "Reinterpretations of the late Wisconsinan glacial succession at Wedron, Illinois: interpretations for stratigraphic nomenclature and interpretations of ice-margin fluctuations" at the Geological Society of America Penrose Conference on Glacial Facies Models, Toronto, Ontario, Canada, in May 1987. At the XII International Congress of the International Union for Quaternary Research in Ottawa in August 1987 she presented a poster

session "Fluctuations of the late Wisconsinan (Woodfordian) Lake Michigan lobe in Illinois, USA," and participated in field excursions on "Outwash and glacial erosion features in the Gananque-Kingston area south of Ottawa" and "Drumlins and erosion marks in southern Ontario."

Richard D. Harvey presented the invited paper "Abundances and origins of major minerals in the Herrin Coal of the Illinois Basin" at the Engineering Foundation Conference in Santa Barbara, CA, February 22-26, 1988.

Randall E. Hughes presented the paper "Geology, history, and future of Industrial clays in Illinois" at the 23rd Forum on the Geology of Industrial Minerals, May 11-15, 1987 in North Aurora, IL. At the Illinois Coal Development Board 5th Annual Contractors' Technical Meeting, July 28-30, 1987, Urbana, IL, Dr. Hughes presented the paper "Carbon monoxide/ethanol desulfurization of Illinois high sulfur coal." He also presented the paper "Development of the carbon monoxide/ethanol desulfurization process" at the Second International Conference on Processing and Utilization of High Sulfur Coals in Carbondale, IL, September 28-October 1, 1987. At the 24th Annual Clay Minerals Conference in Socorro, NM, October 18-22, 1987, he presented the papers "Distribution and significance of illite polytypes in Paleozoic strata of Illinois" and "Clay mineral barriers to waste migration."

John P. Kempton presented the poster session "Applied geology of the proposed site for the Superconducting Super Collider in Illinois" at the annual meeting of the Geological Society of America in Phoenix, AZ, October 26-29, 1987.

Latif A. Khan presented a poster session on "Underground mining methods" at the 1987 National Symposium on Mining, Hydrology, Sedimentology and Reclamation in Springfield, IL, December 7-11, 1987, and served on the advisory committee that assisted in planning the meeting. He also attended the 23rd Forum on the Geology of Industrial Minerals in North Aurora, IL, May 1987.

Myrna M. Killey presented the paper "An active landslide in Iroquois County, Illinois: Conclusions" at the annual meeting of the North-Central Section, Geological Society of America in Akron, OH, April 21-22, 1988.

Robert J. Krumm presented the paper "Geologic applications of a geographic information system: development of a coal mine information database" at the 1987 National Symposium on Surface Mining, Hydrology, Sedimentation and Reclamation in Springfield, IL, Dec. 7-11, 1987.

Carl W. Kruse attended the Illinois Coal Development Board Fifth Annual Contractors' Technical Meeting, April 28-30, 1987, Urbana, IL, where he presented the paper "The Illinois Basin coal sample program."

Timothy H. Larson attended the Spring meeting of the American Geophysical Union in Baltimore, MD, May 18-22, 1987, where he presented the paper "Infiltration through layered soil trench covers: response to an extended period of rainfall."

John M. Masters presented the paper "Effects of different kinds of rocks in Illinois gravels on freeze/thaw test beams" at the 23rd Forum on the Geology of Industrial Minerals at North Aurora, IL, May 11-15, 1987.

Dennis P. McKenna attended the annual meeting of the Illinois Weed Science Affiliates at Allerton House, Monticello, IL, November 2, 1987 where he presented the paper "Pesticides in groundwater in Mason County, Illinois. Later that month at "Pesticides and Pest Management," the annual conference of the Department of Energy and Natural Resources in Chicago, IL, November 12-13, 1987, he presented the talk "Agricultural chemicals in groundwater in Mason County." A talk of the same title was presented at the Annual Conference of the Illinois State Section of the American Water Resources Association in Champaign, April 28-29, 1987. At Des Moines, IA, March 21-23, 1988, at the conference on "Agricultural Impacts on Groundwater"

sponsored by the National Water Well Association, Mr. McKenna presented the talk "Assessment of the occurrence of agricultural chemicals in groundwater in a part of Mason County, Illinois."

Donald G. Mikulic presented the paper "Taphonomic control of Silurian nautiloid cephalopod faunas in reef and non-reef environments" in the poster sessions at the annual meeting of the Geological Society of America, Phoenix, AZ, October 26-29, 1987. He also presented the paper "Distribution and depositional environments of the westernmost Devonian rocks in the Michigan Basin" at the Second International Symposium on the Devonian System at Calgary, Alberta, Canada, in August 1987.

Kathleen W. Miller attended the Second International Conference on Processing and Utilization of High Sulfur Coals in Carbondale, IL, September 28 - October 1, 1987, where she presented the paper "Microbial desulfurization of coal chars using *Thiobacillus ferroxidans*."

Michael V. Miller attended the annual meeting of the Soil Conservation Society of America where he presented a poster session on "Geomorphic aspects of the Des Plaines River wetlands demonstration project," August 2-5, 1987, at Billings, MT.

Russel A. Peppers attended the annual meeting of the North-Central Section, Geological Society of America, April 21-22, 1988 at Akron, OH, where he presented the paper "Palynological correlation of major Pennsylvanian (upper Carboniferous) time-stratigraphic boundaries in the Illinois Basin with those in other coal regions of Euramerica." He also presented this paper at the Sixth Midcontinent Paleobotany Symposium, June 3-5, 1988, at Champaign. At the spring field trip of the Pennsylvanian Working Group, Society of Economic Paleontologists and Mineralogists, May 22-23, 1987 in Kansas, Oklahoma, and Missouri, Dr. Peppers prepared and discussed palynological identifications of coals seen at the field trip stops.

Richard B. Read attended the Second International Symposium on the Processing and Utilization of High-Sulfur Coals in Carbondale, IL, September 28 - October 1, 1987, where he presented the paper "Advanced physical fine coal cleaning: Developments in pyritic sulfur and ash reduction of Illinois coals by ISGS aggregate flotation."

Philip C. Reed presented the paper "Delineating an abandoned mine tunnel using vertical electrical soundings at a landfill, Vermilion County, Illinois" at the 80th annual meeting of the Illinois State Academy of Sciences, Charleston, IL, April 10-11, 1987.

J. Bruno Risatti attended the annual meeting of the Geological Society of America In Phoenix, AZ, October 26-29, 1987, where he presented the paper "Biogeochemistry of a temperate zone peat bog." At the Illinois Coal Development Board 5th Annual Contractors' Technical meeting, July 28-30, 1987, Urbana, IL, Dr. Risatti presented the paper "Microbially enhanced separation of pyrite from Illinois coals, Part A: Mechanisms and enhancement of suppression."

Massoud Rostam-Abadi attended the annual meeting of the American Chemical Society Division of Fuel Chemistry in New Orleans, LA, in August 1987, where he presented the paper "Sulfur dioxide sorption reactivity of hydrated lime: effect of hydration method." He also attended the Sixteenth Annual Meeting of the North American Thermal Analysis Society in Washington, DC, September 27-30, 1987. At the Illinois Coal Development Board 5th Annual Contractors' Technical Meeting, July 28-30, 1987, Urbana, IL, Dr. Rostam-Abadi presented the paper "Reactivities and combustion properties of coal and coal-derived solid fuel, Part A: Sample preparation, characterization and reactivity measurements."

Beverly Seyler presented the paper "Exploration model for shallow Silurian (Kankakee) carbonate reservoirs in western Illinois" at the poster sessions of the annual meeting of the Eastern Section, American Association of Petroleum Geologists, in Columbus, OH, October 8, 1987. The same posters also were displayed at the Illinois Oil and Gas Association spring meeting held in Evansville, IN, March 3-4, 1988.

Thomas H. Shaw presented the paper "Lower Ordovician conodonts from the Shakopee Dolomite (upper Prairie du Chien Group) in southwestern Illinois" at the Pander Society symposium, at the annual meeting of the North-Central Section, Geological Society of America in Akron, OH, April
Michael D. Stephenson and Keith C. Hackley jointly presented the paper "Desulfurization of Illinois coals by thermal, chemical and magnetic methods" at the Illinois Coal Development Board 5th Annual Contractors' Technical Meeting, July 28-30, 1987, Urbana, IL. Mr. Stephenson presented the paper "Influence of physical cleaning and oxidation on the hydrodesulfurization of coal chars" at the Second International Conference on Processing Utilization of High Sulfur Coals, Carbondale, IL, September 28 - October 1, 1987.

Wen-June Su presented the paper "Engineering geology aspects of a project entitled 'Earthen Liners: A Field Study of Transit Time'" at the meeting of the North Central Section of the Association of Engineering Geologists in Chicago, September 22, 1987, and at the 30th annual national meeting of the AEG in Atlanta, October 8-12, 1987. At the annual meeting of the North Central Section of the Geological Society of America, April 20-22, 1988 in Akron, OH, he presented "Evaluation of five Illinois soils for earthen liners."

Colin G. Treworgy attended the annual meeting of the American Congress of Surveying and Mapping, March 13-16, 1988, St. Louis, MO, where he presented the paper "Costs and benefits of GIS data management: a case study of a database managed by a state agency." At the Midwest Regional ARC/INFO Users Conference in Champaign, October 14-16, 1987, he discussed "GIS data management and the Illinois coal mine information system."

Robin L. Warren presented the paper "Evaluation of the economic usefulness of earth materials by x-ray diffraction" at the 23rd Forum on the Geology of Industrial Minerals, May 11-15, 1987, at North Aurora, IL. At St. Louis, MO, July 28, 1987, at the Fifth Annual National Conference on Alcohol Fuels, he presented the paper "Carbon monoxide/ethanol desulfurization of Illinois high-sulfur coal: a technical overview."

C. Pius Weibel attended the 11th International Congress of Carboniferous Stratigraphy and Geology in Beijing, China, August 31 - September 4, 1987, where he presented the papers "Paleoenvironmental analysis of Pennsylvanian (Bashkurian to Gzhelian) Syringoporoids, Arrow Canyon Range, Nevada, USA" and "Lateral continuity and lithologic variation of cyclothems in the Virgilian (upper Kasimovian-Gzhelian) outlier, Illinois Basin, USA." He also attended the annual meeting of the Geological Society of America in Phoenix, AZ, October 26-29, 1987, where he presented the paper "Major changes in the pathway of transgressive epicontinental seas into the Illinois Basin during middle Desmoinesian."

Stephen T. Whitaker attended the annual meeting of the Eastern Section, American Association of Petroleum Geologists, October 7-10, 1987 at Columbus, OH, where he presented poster sessions on "Silurian pinnacle reef distribution in Illinois: a model for hydrocarbon exploration" and, with his co-author **R.H. Howard,** "Hydrocarbon accumulation in basal Pennsylvanian fluvial sandstone near Hardinville, Illinois: a model paleogeomorphic trap." At a symposium on sandstone reservoirs in New Orleans, LA, June 10-11, 1988, he presented the talk "Fluvial sandbar in a paleovalley at the Mississippian-Pennsylvanian unconformity, Crawford County, Illinois: a model for a paleogeomorphic trap" which he and Mr. Howard developed from the earlier poster session. Mr. Whitaker repeated his presentation of the prize-winning poster session on "Silurian pinnacle reef distribution" at the annual meeting of the Illinois Oil and Gas Association, March 3-4, 1988 at Evanston, IN, and gave a talk at that meeting on "Exploration for Silurian reefs in the Illinois Basin." At the monthly meeting of the Society of Petroleum Engineers in Mt. Vernon, IL, May 10, 1987, Mr. Whitaker discussed the proposed Illinois Basin Ultradeep Drillhole.

Lawrence Wu attended the Fifth Annual National Conference on Alcohol Fuels, July 28, 1987 at St. Louis, MO, where he presented the paper "Carbon monoxide/ethanol desulfurization of Illinois high-sulfur coal: a preliminary economic overview."

Scientific Workshops/Training Courses Attended or Taught

Robert A. Bauer, R. Todd Black, Joan E. Crockett, Ilham Demir, Gary Dreher, J. James Eidel, Alison Lecouris, Edward Mehnert, Donald F. Oltz, Beverly J. Seyler, Janis D. Treworgy, and Stephen Whitaker attended a slide and audio tape short course entitled "Geological Applications of Reservoir Engineering Tools" presented at the ISGS on June 2, 1988. The short course, designed by John Farina, Consulting Petroleum Engineer from Kingswood, TX, is marketed by the American Association of Petroleum Geologists.

James W. Baxter presented the paper entitled "Underground mining of limestone and dolomite in Illinois, with special reference to central Illinois" at the annual aggregates seminar of the Illinois Department of Transportation, Division of Highways, Moline, IL, April 1988.

Subhash B. Bhagwat, Joan E. Crockett, J. James Eidel, Paul C. Heigold, Morris W. Leighton, E. Donald McKay III, Duane M. Moore, Donald F. Oltz, Beverly J. Seyler, and Janis D. Treworgy participated in the Mid-Continent Regional Forum at St. Louis, MO., June 9-10, 1988, sponsored by the Geoscience Research Institute of Austin, TX. **Suzanne Muckensturm** organized the meeting and supervised arrangements and **Eileen Hardegree and Dorothy M. Spence** served as administrative assistants for the conference, providing special secretarial services for the conferees.

Richard C. Berg attended the workshop on hydrogeologic mapping sponsored by the U.S. Geological Survey and the U.S. Environmental Protection Agency in Denver, CO, May 10-12, 1988. At the Illinois Sprayers Conference at the Illini Union in Champaign, January 6, 1988, Dr. Berg presented a lecture on pesticides in groundwater.

Dwain J. Berggren, Joan E. Crockett, Paul B. DuMontelle, John M. Masters, W. John Nelson, Michael L. Sargent, C. Brian Trask, and Robert C. Valden attended a short course on "Technical Review of Geological Maps" taught at the ISGS by Mitchell Reynolds of the U.S. Geological Survey, March 29-31, 1988.

Dwain J. Berggren, Lucille M. Curran, David L. Gross, and Latif A. Khan attended a workshop on conflict management taught at the ISGS by Dr. Randall K. Stuttman of the Department of Speech Communications, University of Illinois, May 12, 20, and 24, 1988.
Subhash B. Bhagwat attended a workshop on "Scrub-Switch Decisions" sponsored by the Electric Power Research Institute at St. Louis, MO, Oct. 27-28, 1987, and a seminar on "Cost Estimation" sponsored by the U.S. Bureau of Mines in Washington, DC, June 1-2, 1987.

R. Todd Black, Joan E. Crockett, J. James Eidel, Anne M. Graese, Richard H. Howard, Bryan G. Huff, E. Don McKay, III, Duane M. Moore, Rodney D. Norby, Donald F. Oltz, Michael L. Sargent, Beverly J. Seyler, Janis D. Treworgy, Stephen T. Whitaker and 13 others from outside the ISGS attended a short course on "Characterizing Heterogeneous Reservoirs" taught at the ISGS on May 2, 1988, by Noel Tyler and Jerry Lucia of the Texas Bureau of Economic Geology.

Chen-Lin Chou taught a short course entitled "Trace Element Geochemistry: Principles and Methods" sponsored by and held at the Institute of High Energy Physics, Academia Sinica, Beijing, China, August 24-28, 1987. Lecture notes totaling 103 pages were distributed to the 50 participants.

Joseph Chou attended training courses on the operation of gas chromatograph/mass spectrograph instruments and on qualitative and quantitative analysis of US EPA priority organic pollutants at the Hewlett-Packard Training Center, New Orleans, LA, April 20-24 and May 19-22, 1987. He also attended a training course in the use of the "Bioplume" computer modeling program for biodegradation and biotransformation in Pensacola, FL, November 9, 1987.

Michael J. Chrzastowski attended a workshop on Great Lakes Coastal Erosion Research Needs sponsored by the Michigan Sea Grant College Program, July 8-9, 1987 at Ann Arbor, MI, where

he presented the paper "Illinois State Geological Survey role in Great Lakes coastal engineering research." He also attended training courses at the University of Illinois on the use of Lotus 1-2-3 on November 4-13, 1987, and of WordPerfect on January 5-14, 1988.

Charles Collinson participated in a two-day workshop for coastal engineers, architects, and land planners sponsored by the Structural Measures Working Group of the Chicago Shoreline Protection Commission, May 18-19, 1987, at the headquarters of the Chicago Park District. He also served as a critical reviewer at a charette on new plans for a Loyola University shore development sponsored by the American Institute of Architects, August 5, 1987, in Chicago.

Joan E. Crockett and Donald F. Oltz attended a short course on seismic exploration methods at the meeting of the Eastern Section, American Association of Petroleum Geologists at Columbus, OH, October 7, 1987. Ms. Crockett, **Michael L. Sargent and Janis D. Treworgy** attended a short course on interpretation of geophysical well logs in carbonate terrains taught by AAPG distinguished lecturer George Asquith and sponsored by the Indiana-Kentucky Geological Society, April 22, 1988 at Evansville, IN. Ms. Crockett also was a co-organizer and participated, with Dr. Oltz and Mr. Sargent, in a symposium on the Salem Formation sponsored by the Illinois Geological Society and held at Mt. Vernon, IL, January 22, 1988.

Joan E. Crockett, Joseph A. Devera, Paul C. Helgold, Richard H. Howard, Russell J. Jacobson, Dennis R. Kolata, E. Donald McKay III, W. John Nelson, Donald F. Oltz, Michael L. Sargent, Beverly J. Seyler, C. Brian Trask, Janis D. Treworgy, C. Pius Weibel, Stephen T. Whitaker, and 15 faculty members and graduate students from the Geology Department of the University of Illinois attended the seminar/workshop on "Concepts and Applications of Seismic Stratigraphy" taught at the ISGS by Dr. Peter Vail of Rice University, April 24, 1987.

William Dey took the class "Biochemical processes in the soil and water environment" at the University of Illinois at Urbana-Champaign," August - December 1987.
Donald R. Dickerson took the Gas Chromatography/Mass Spectroscopy System Manager training course at the Hewlett-Packard Training Center, New Orleans, LA, June 12-19, 1987.

Leon R. Follmer reviewed ISGS activities in the area of Quaternary geology for the annual workshop of the Soil Conservation Service.

Robert R. Frost attended a user training course for the new x-ray fluorescence spectrometer taught by Rigaku USA at Danvers, MA, August 4-7, 1987.

Anne M. Graese and Robert C. Vaiden attended the short course on "Fundamentals of Groundwater and Well Technology" offered by the National Water Well Association at Columbus, OH, November 10-12, 1987.

David L. Gross attended a short course on environmental auditing taught in California in November 1987.

Jonathan H. Goodwin presented the slide-illustrated talk "Groundwater--Our Hidden Resource" and participated in panel discussions at five workshops organized by the Department of Energy and Natural Resources to educate community water supply operators, agricultural chemical suppliers, and public officials about the provisions of the new Groundwater Protection Act. The talk was expanded and modified from one developed originally by **Dennis P. McKenna**. Workshops were held March 15 at Jacksonville, March 16 at Mt. Vernon, March 21 at Bloomington, March 22 at Rock Falls, and March 23, 1988 at Elgin. Dr. Goodwin and **Philip C. Reed** also attended a workshop sponsored by the Environmental Education Association of Illinois, April 21-22, 1988, at Wildwood Girl Scout Camp near Mt. Sterling, to develop Illinois-oriented classroom exercises about groundwater geology, groundwater protection, and groundwater contamination problems for use by Illinois teachers. The workshop was sponsored by the Department of Energy and Natural Resources as part of the Education Program under the new

Illinois Groundwater Protection Act. At the annual meeting of the Geological Society of America in Phoenix, AZ, October 26-29, 1987, Dr. Goodwin and **C. Pius Weibel** participated in a one-day short course on Quantitative Sedimentary Basin Modeling.

Steven W. Harrison participated in the workshop "Winning Grants - Administrator's Program" at the Levis Faculty Center, February 18, 1988.

Paul C. Helgold attended short courses on "Seismic Stratigraphy," "Seismic Expression of Structural Styles," and "Special Seismic Stratigraphy Techniques" at the annual meeting of the American Association of Petroleum Geologists in Denver, CO, April 1988.

Bruce R. Hensel attended short courses on "Applied Groundwater Modeling", October 5-9, 1987 and "Flow and Transport in Unsaturated Zones", April 18-22, 1988, at the International Groundwater Modelling Center of the Holcomb Research Institute, Indianapolis, IN.

Beverly L. Herzog presented a talk on "Wilsonville: historical perspectives and current research" for a seminar at the Hazardous Waste Research and Information Center in Savoy, IL, March 1987. At a University of Wisconsin Department of Engineering Professional Development short course on "Subsurface Monitoring Technology" at Madison, WI, in April 1987 she presented the talk "Monitoring experiences at the Wilsonville Landfill." She also attended a U.S. EPA seminar on "Fate and Transport of Contaminants" in Chicago in September 1987.

Randall E. Hughes and Duane M. Moore attended a Scintag X-ray diffractometer operators' training course November 17-19, 1987.

Russell J. Jacobson attended a short course on "Public Domain Geological Software for PCs" taught by David Rich, president of the national Computer Oriented Geological Society. The short course was offered at the fall 1987 meeting of the Illinois Basin Section of COGS.

Donald A. Keefer completed two courses, "Soil microbiology" and "Soil genesis, classification and morphology" toward his master's degree in soil science at the University of Illinois at Urbana-Champaign.

Latif A. Khan participated in the short course on use of WordPerfect taught by Thane Johnson of the ISGS during the summer of 1987.

Myrna M. Killey and C. Brian Trask attended a short course on "Ground Water Monitoring Principles and Sampling Techniques" at the University of Kentucky, Lexington, KY, March 3-4, 1988. They also attended the workshop on the Illinois Groundwater Protection Act at Rock Falls, IL, March 23, 1988. Earlier, at the workshop for participants in the Paducah CUSMAP project held in Carbondale, IL, August 5, 1987, Ms. Killey presented a lecture on methods of Quaternary mapping.

Dennis R. Kolata was one of about 75 participants at a workshop on "Quantitative dynamic stratigraphy" sponsored by the American Association of Petroleum Geologists, Colorado School ofMines, Gas Research Institute, National Science Foundation, U.S. Department of Energy and U.S. Geological Survey, February 14-18, 1988 at Lost Valley Ranch, Deckers, CO. At the workshop, Dr. Kolata presented a poster session on "Chemical correlation of K-bentonites in the Upper Ordovician Decorah Subgroup of the Upper Mississippi Valley," participated in the preparation of group report on the present status of quantitative dynamic stratigraphy, and proposed new research directions for the field.

Albert Kraus attended twelve hours of training in programming of the DBase III+ database management system at the University of Illinois at Urbana-Champaign.

Robert J. Krumm attended a workshop on digital cartographic mapping standards presented by the U.S. Geological Survey National Mapping Division at Denver, CO, June 8-9, 1988.

Morris W. Leighton attended a research conference and workshop on "Petroleum potential of sedimentary basins - methods, techniques and approaches" sponsored by the American Association of Petroleum Geologists, April 26-29, 1988 at Leesburg, VA.

Donald J. Lowry attended a graduate course in operation of scanning electron microscopes and specimen preparation at the University of Illinois, and an operator's training session for the energy dispersive analysis system of the new scanning electron microscope taught by Tracor Northern Corporation.

John M. Masters audited the graduate seminar on paleosols in the Geography Department, University of Illinois at Urbana-Champaign during the spring semester of 1988. On August 1-4, 1987, he attended the National Sand and Gravel Association Sand and Gravel Operators' Forum and Plant Tours in the Chicago area and presented geological information at each of the stops on the field trip. He also attended the Illinois Department of Transportation Aggregate Seminar and Field Conference in Moline, IL, April 19-21, 1987.

E. Donald McKay III attended the workshop on Computational Geoscience sponsored by the National Science Foundation at Champaign, IL, April 1987. In October 1987 he attended a workshop on "Orpheus Geoprocessing Integration" at Natick, MA, and in November 1987 he met with U.S. Geological Survey scientists at the National Center for Supercomputing Applications in Champaign to explore possible cooperation with the Center. In May 1988 he attended a workshop on "Digitizing Global Geoscience Transects" at the U.S. Geological Survey in Reston, VA, and in early June 1988 he participated on the panel on databases at the Mid-Continent Regional Forum sponsored by the Geoscience Research Institute in St. Louis, MO.

Dennis P. McKenna presented the talk "Preliminary assessment of the potential for agricultural contamination of shallow aquifers in Illinois" at the 1988 Illinois Fertilizer Conference, January 26-27, 1988, in Peoria, IL. At the Annual Educational Conference of the National Environmental Health Association in Cleveland, OH., June 28, 1988, he discussed "Considerations in monitoring agricultural chemicals in groundwater." At a technical session on Pesticides in Groundwater held at the College of Agriculture, University of Illinois at Urbana-Champaign on February 9, 1988, Mr. McKenna presented a talk on "Pesticides in shallow groundwater in Mason County, Illinois," and at the Illinois Crop Pro-Tech workshop in Champaign, January 7, 1988, he discussed the "Potential for agricultural chemical contamination of groundwater in Illinois."

Edward Mehnert presented the talk "Investigation of the hydraulic effects of deep-well injection" at the technical workshop on underground injection in Denver, CO, September 23-25, 1987.

Michael V. Miller attended the workshop "Constructed Wetlands for Waste Water Treatment" sponsored by the Tennessee Valley Authority at Chattanooga, TN, June 13-17, 1987. He also attended the workshop "Hydrology of Wetlands" sponsored by the University of Minnesota Department of Forestry, September 14-18, 1987 at St. Paul, MN.

Duane M. Moore attended the annual meeting of the Clay Minerals Society, Socorro, NM, in October 1987, where he attended a workshop on electron beam instrumentation.

Vickie R. Poole attended a short course on "Borehole Geophysical Techniques for Solving Ground Water Problems" sponsored by the National Water Well Association in Alexandria, VA, May 2-4, 1988.

David L. Reinertsen, head of the Educational Extension Unit, presented "An Introduction to the Geology of Coal in Illinois" at teacher workshops in Clinton, July 14; Flossmoor, July 27; and Carterville, August 11, 1987. At the Illinois Science Teachers' annual meeting in Peoria, October

16, 1987, he presented workshops on the "Satellite Image Map of Illinois" and "An Introduction to the Use of Illinois Topographic Maps." Mr. Reinertsen presented the same two workshops at the Illinois Drafting Educators Association annual meeting in Galesburg, November 13, 1987.

William R. Roy attended the workshop on Leaching Tests at the Waste Management Technology Center, Oak Ridge, TN, July 21-24, 1987 where he presented the paper "Laboratory extraction of solid wastes: experiences and observations."

Michael L. Sargent took the course "Introduction to Microcomputers" during the fall semester 1987 at Parkland College in Champaign, and the mini-course "Introduction to WordPerfect" at the University of Illinois at Urbana-Champaign. He also participated in a course on boating safety taught by the U.S. Coast Guard Auxiliary at Urbana High School and Parkland College.

Beverly J. Seyler participated in a workshop on "Clay Mineralogy and Applications to Petroleum Geology" at the annual meeting of the American Association of Petroleum Geologists, April 22-23, 1988. During June of 1988, **Ms. Seyler** took an in-house training course on the use of the AMRAY 1830 Scanning Electron Microscope. She was also trained in the operation of the Microtech thin section grinding machine at Grand Junction, CO, Nov. 12-15, 1987.

Christopher J. Stohr attended the workshop on Side-Looking Airborne Radar sponsored by the U.S. Geological Survey at Reston, VA, April 21-23, 1987.

John D. Steele attended an operator's training course for the Thermo-Jarrell-Ash Model 1100 inductively coupled argon plasma spectrophotometer at Franklin, MA, May 10-13, 1988.

Wen-June Su attended a short course on "Ground Failures: Geotechnical Problems from Geologic Oversight" at the annual meeting of the Association of Engineering Geologists, October 10, 1987, at Atlanta, GA.

Colin G. Treworgy was co-instructor with Michael Seal of BPB Instruments, Incorporated, for a short course on "Use of Geophysical Logs for Exploration and Development of Coal" presented at the annual meeting of the Illinois Mining Institute, September 30-October 1, 1987, Mt. Vernon, IL.

Participation in Scientific Conferences/Field Trips

Robert A. Bauer, B. Brandon Curry, Lucille M. Curran, David L. Gross, Anne M. Graese, Carol A. Hindman, Jennifer K. Hines, John P. Kempton, Robert C. Vaiden and others met with members of the U.S. Department of Energy SSC siting team at Fermilab and at the ISGS in Champaign, May 16 - 19, 1988.

Robert A. Bauer, B. Brandon Curry, Lucille M. Curran, David L. Gross, Anne M. Graese, Carol A. Hindman, Jennifer K. Hines, John P. Kempton, Robert C. Vaiden and others met with the members of the SSC siting team from RTK Consulting Engineers, Incorporated, at Fermilab and at the ISGS in Champaign, March 21 - 25, 1988.

Robert A. Bauer attended the meetings of the Illinois Groundwater Association in Aurora, IL, October 28, 1987, where he made a presentation on the ISGS geological and geotechnical studies for siting the SSC in Illinois. Mr. Bauer also attended the National Meeting of the Association of Engineering Geologists in Atlanta, GA, in October 1987, where he received the Douglas R. Piteau Award recognizing him as the outstanding young member of the organization. At the Illinois Mining Institute in Mt. Vernon, IL, October 1987, he presented a display on the current status of the Illinois Mine Subsidence Research Program.

Richard C. Berg presented a paper entitled "Siting and characterization for a low-level radioactive waste disposal facility ion Illinois" to the Illinois-Indiana Section of the American Institute of Professional Geologists meeting at Aurora, IL, November 13, 1987.

Subhash B. Bhagwat attended the 23rd Forum on the Geology of Industrial Minerals in North Aurora, IL, May 19-23, 1987 where he presented the paper, "Modeling construction aggregate demand and supply: a Chicago area case study."

Ross D. Brower and Philip C. Reed presented a display featuring borehole geophysics interpretive mapping and particle size analysis for purposes of well design at the Midwest Groundwater Exposition and Annual Meeting of the Illinois Water Well Association at Pheasant Run Resort near St. Charles, IL, March 7-8, 1988.

Chen-Lin Chou participated in a field trip on the Carboniferous and Permian stratigraphy of the Shanxi Coal Field during the XI International Conference on Carboniferous Stratigraphy and Geology in the People's Republic of China, September 5-12, 1987.

Joseph Chou attended the Eighth Annual Meeting of the Society of Environmental Toxicology and Chemistry, November 9-12, 1987, at Pensacola, FL.

Michael J. Chrzastowski was one of several leaders/participants in a joint U.S. Geological Survey, Indiana Geological Survey, ISGS working field conference along the southern Lake Michigan shoreline, May 23-24, 1988. He also hosted a one-week tour of the southern Lake Michigan shore, August 11-19, 1988, for Dr. Kelvin W. Ramsey, coastal geologist from the Delaware Geological Survey in Newark, DE.

Charles Collinson attended a field conference June 15-16, 1988 in Ottawa, Canada, to observe wave tank testing of proposed shore protection structures for the planned Loyola University of Chicago shore development. Tests were performed at the National Research Council of Canada's National Hydraulics Laboratory. Dr. Collinson discussed ISGS studies of Lake Michigan at an evening session during the conference.

Joan E. Crockett, J. James Eidel, and Morris W. Leighton attended the U.S. Geological Survey's McKelvey Forum in Denver, CO, March 1-2, 1988.

B. Brandon Curry and Ardith K. Hansel led a field trip in the Lemont and Elgin areas on the "Stratigraphy, engineering properties and waste disposal characteristics of glacial deposits in the Chicago area" on April 30, 1988 for about 50 members of the North-Central Section of the Association of Engineering Geologists.

Joseph A. DeBarr attended the 21st Great Lakes Regional Meeting of the American Chemical Society in Chicago, IL, June 10-12, 1987, and the Chicago Area Thermal Analysis Society meeting, November 12, 1987.

William Dey presented his research on computer modeling to predict the impact of pesticides on groundwater at the Water Quality Symposium of the Illinois Weed Science Affiliates, held at Allerton House in Monticello, IL, November 2, 1987.

Gary B. Dreher and Massoud Rostam-Abadi visited Kerr-McGee's Galatia Mine coal preparation plant and Old Ben Coal Company's preparation plant at Benton and met with plant engineers at both mines to discuss coal preparation and waste disposal methods.

Paul B. DuMontelle presented the exhibit on the Illinois Mine Subsidence Research Program at the Illinois Mining Institute in Mt. Vernon, September 30, 1987; at the National Symposium on Mining, Hydrology, Sedimentology and Reclamation in Springfield, IL, December 9-11, 1987; and at Engineering Open House at the University of Illinois at Urbana-Champaign, March 3, 1988. Mr. DuMontelle also attended the technical sessions at the IMI, the National Mining Symposium and the National meeting of the Association of Engineering Geologists in Atlanta, GA., October 8-13, 1987. On April 30, 1988 he attended the spring field trip of the North Central Section of the Association of Engineering Geologists at Lemont and Elgin.

Henry P. Ehrlinger, III chaired the session on "Business opportunities and management of environmental wastes" at the annual meeting of the Society of Mining Engineers in Phoenix, AZ, January 25-28, 1988. He also served as co-treasurer with **Jonathan H. Goodwin** for the meeting of the 23rd Forum on the Geology of Industrial Minerals, May 12-15, 1987 in North Aurora, IL, and assisted in the organization and operation of field trips for the meeting.

J. James Eidel represented the ISGS at the Central Region Cluster meeting with the U.S. Geological Survey in Denver, September 14-17, 1987. He also used the opportunity to discuss topical studies being conducted by the USGS for the Paducah CUSMAP project.

Leon R. Follmer attended the meeting of the Midwest Friends of the Pleistocene in Mansfield, OH, in May, 1987, and the meeting of the International Union of Quaternary Research in Ottawa, Canada, July 31 - August 9, 1987. Following the INQUA meeting, Dr. Follmer, **John M. Masters and E. Don McKay III** escorted the members of the INQUA Commission on Loess on a tour of the loess sequences of the Mississippi Valley, August 10-18, 1987. In Warm Springs, OR, in September 1987, Dr. Follmer led a discussion session on the influence of topography on soil formation at the Geological Society of America Penrose Conference entitled "Environmental Interpretations of Paleosols." Also in September 1987, he led a field trip to Mercer County for the Illinois Soil Classifiers Association to examine soil genesis. The following month, Dr. Marcelo Zarate of the Universite Nacional de Mar del Plata, Argentina, toured Illinois loess sequences for two days with Dr. Follmer in order to compare Illinois' sequences with those in Argentina. Also in October, Dr. Follmer summarized his tour of Mississippi Valley loess sequences for a meeting of the Illinois Quaternary Association in Carbondale. Dr. Follmer also attended the winter meeting of ILQUA in Springfield in March 1988, the annual meetings of the Illinois Soil Classifiers Association in Mahomet in March 1987 and in Peoria in March 1988, and the North Central Section meeting of the Geological Society of America in St. Paul, MN, in April 1987.

Anne M. Graese presented the talk "Geological and geotechnical aspects of siting the superconducting super collider (SSC) in northeastern Illinois: regional geology and test drilling program" at the Illinois Groundwater Association meeting at Naperville, IL, October 28, 1987. At the same meeting, **Robert C. Vaiden** presented the talk "Regional hydrology from a tunneling perspective."

David L. Gross was one of the State of Illinois representatives at the SSC bidders conference in Washington, DC, in April, 1987. In May 1987, he toured the CERN accelerator site in Switzerland and the DESY accelerator site in West Germany. He also represented the State at a national conference on the SSC held in Denver in December 1987 and attended environmental scoping meetings for rival SSC sites in North Carolina and Colorado in February, 1988.

Ardith K. Hansel led a discussion and lecture on "Revising Quaternary classification" at the Illinois Quaternary Association meeting in Springfield in March 1988. Later in the spring, she discussed glacial and lake history at the field conference "Lake phases and glaciofluvial sequences of the Lake Michigan basin" sponsored by the Midwest Friends of the Pleistocene in southwestern Michigan, May 21-22, 1988. Immediately afterward she joined colleagues from the Indiana and U.S. Geological Surveys in a working field conference for the Lake Level And Sedimentation History (LLASH) subgroup of the Southern Lake Michigan Shore Erosion Cooperative Project to examine potential sites where Lake Michigan levels and sedimentation history can be studied. In early June 1988 she attended the 10th biennial meeting of the American Quaternary Association in Amherst, MA, where she participated in a field excursion on "Glacial and deglacial landforms of the Amherst area, north central Massachusetts".

Richard D. Harvey attended the Spring meeting of Committee D-5, Coal and Coke, of the American Society for Testing and Materials in Pittsburgh, PA, May 19, 1987. At the meeting he presented the paper "Overview of classification of coal by rank" and presented the Committee's R.A. Glenn Award. At the Fall meeting of the Committee in St. Louis, MO, October 6, 1987, he organized a technical session of five speakers on the topic of "Tax implications for moisture

determinations." In February 1988, Dr. Harvey attended the Engineering Foundation Conference on Mineral Matter and Ash in Coal in Santa Barbara, CA, where he presented the paper "Abundance and origin of major minerals in the Herrin Coal."

Paul C. Helgold attended a conference on the national seismic network held at St. Louis University, St. Louis, MO, in April 1987.

Beverly L. Herzog and colleague Karen A. Albrecht presented the paper "Earthen liners: Prototype phase of a field study of transit time" at the 14th Annual U.S. EPA Symposium on Land Disposal, Remedial Action and Treatment of Hazardous Waste in Cincinnati, OH, in May 1987. She also attended the Symposium on Standards Development for Ground Water and Vadose Zone Monitoring sponsored by the American Society for Testing and Materials in January 1988 in Albuquerque, NM where she presented the paper "Comparison of slug test methodologies for determination of hydraulic conductivities in fine-grained sediments." At the Second National Outdoor Action Conference on Aquifer Restoration, Groundwater Monitoring and Geophysical Methods, May 23-26, 1988, in Las Vegas, NV, Ms. Herzog presented the paper "Changes in volatile organic chemical composition after purging slowly recharging wells."

Carol A. Hlndman attended the 1988 Environmental Science Research Institute User Conference in Palm Springs, CA, March 21-25, 1988. She also attended the National Symposium on Mining, Hydrology, Sedimentology and Reclamation in Springfield, IL, December 7-8, 1987, the Western Great Lakes Regional Meeting of the American Society for Photogrammetry and Remote Sensing in Urbana, November 1987, and the first annual Great Lakes-Midwest Regional ARC/INFO User Conference in Champaign, October 15-16, 1987. She also attended three meetings in Chicago with representatives of Bally Midway Company, Incredible Technologies, Incorporated, and SSC for Fermilab, Incorporated, to provide geologic information and develop quiz questions for the electronic SSC display and video quiz created by Bally as part of the State's SSC publicity effort.

Richard H. Howard presented a poster session on "Hydrocarbon accumulation in basal Pennsylvanian fluvial sandstone near Hardinville, Illinois: a model paleogeomorphic trap" at meetings of the Eastern Section of the American Association of Petroleum Geologists at Columbus, OH, Oct. 8, 1987; the Illinois Oil and Gas Association at Evansville, IN, March 3-4, 1988; and the Kentucky Oil and Gas Association in Owensboro, KY, June 16-17, 1988.

Randall E. Hughes discussed "The clay mineral industry in Illinois" for the Illinois-Indiana Section of the American Institute of Professional Geologists meeting at Evansville, IN, April 29, 1987.

Donald A. Keefer attended the Water Quality Symposium of the Illinois Weed Science Affiliates at Allerton House, Monticello, IL, November 2, 1987, and the ENR conference on "Pests and Pest Management," Rosemont, IL, November 11-13, 1987.

Dennis R. Kolata was co-leader of the pre-meeting field trip "Middle Ordovician stratigraphy and paleontology of the Twin Cities" and the post-meeting field trip "Middle and Late Ordovician lithostratigraphy and biostratigraphy of the Upper Mississippi Valley" held in conjunction with the annual meeting of the North Central Section, Geological Society of America at St. Paul, MN, April 29 - May 3, 1987.

Ivan G. Krapac presented the poster session "A field study: transit times through a compacted clay liner" at the 14th Annual U.S. EPA Research Symposium on Land Disposal, Remedial Action and Treatment of Hazardous Waste in Cincinnati, OH, May 9-11, 1988.

Robert J. Krumm attended the Midwest Regional ARC/INFO Users Group meeting in Champaign, October 14-16, 1987, where he presented a talk on "Geological applications of ARC/INFO: current projects and developments at the Illinois Geological Survey" and a poster session on "Earthquake hazard mapping in Illinois using a geographic information system." At the Great Lakes Regional Section meeting of the American Society for Photogrammetry and Remote

Sensing in Urbana on November 6, 1987, he presented a talk on "ARC/INFO applications at the Illinois State Geological Survey."

Timothy H. Larson presented the talk "Geothermal prospecting: theory and practice" to a meeting of the North Central Section, Association of Engineering Geologists in Chicago, May 24, 1988.

Morris W. Leighton, Jonathan H. Goodwin, and Suzanne Muckensturm attended the annual meeting of the Association of American State Geologists in Lexington, KY, June 13 - 16, 1988. At the meeting, Dr. Leighton discussed "GIS utilization by state geological surveys: results of the 1988 AASG questionnaire" and Ms. Muckensturm discussed the methods she used to organize a breakfast for legislators in February. She and Dr. Goodwin also set up a display showing several publications or programs that have been particularly successful at catching the public's interest.

John M. Masters presented a talk on "Silica sand in Illinois and Indiana" for the meeting of the Illinois-Indiana Section of the American Institute of Professional Geologists held April 24, 1987, at Evansville, IN. He also assisted in running the Park Ridge - North Shore public geoscience field trip on October 3, 1987, and attended the meeting of the Illinois Quaternary Association in Carbondale, IL, October 10, 1987. Mr. Masters attended two field trips and the technical sessions of the 24th Forum on the Geology of Industrial Minerals at Greenville, SC, May 2-6, 1988, and the field conference of the Midwest Friends of the Pleistocene at the Kellogg Biological Station, Hickory Corners, MI, May 21-22, 1988.

E. Donald McKay III attended the meeting of the Midwest Friends of the Pleistocene in Mansfield, OH in May 1987.

Donald G. Mikulic and Joanne Kluessendorf led a field trip on "Classic Silurian reefs of the Chicago area" for the Michigan Basin Geological Society Field Excursion, May 14, 1988.

Michael V. Miller attended the National Symposium on Urban and Riparian Habitats sponsored by the Association of State Wetlands Managers in Oakland, CA, June 25-30, 1988. He also attended the Annual Field Meeting of the Midwest Friends of the Pleistocene at Michigan State University, East Lansing, MI, May 21-22, 1988.

Duane M. Moore presented the invited lecture "David Delo and the founding of the National Association of Geology Teachers" at the annual meeting of the North Central Section of that organization at Augustana College, Rock Island, IL, April 9, 1987.

Donald F. Oltz attended a symposium on "Microbially enhanced oil recovery" sponsored by the Illinois Oil and Gas Association at Mt. Vernon, IL, September 25, 1987. At the meeting of the Illinois Basin Section of the Society of Petroleum Engineers in Mt. Vernon, IL, January 21, 1988, Dr. Oltz presented a talk on "Illinois reservoirs."

Robert R. Pool attended the Midwest Regional ARC/INFO Users Group in Champaign, IL, October 14-16, 1987 where he presented an informal poster session on "The Paducah CUSMAP."

Vickie R. Poole presented the talk "Case studies of oil field brine contamination at two holding ponds in Clay County, Illinois" at the Annual Meeting of the North-Central Section, Geological Society of America, Akron, OH, April 21-22, 1988. Ms. Poole wrote the talk and presented it for the authors of the paper, **Bruce Hensel and Dennis McKenna**.

David M. Rapp attended the annual meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers in Phoenix, AZ, January 24-28, 1988.

Kristy K. Redding, Richard H. Shiley, Robin L. Warren. Randall E. Hughes, Lawrence Wu and others, in various combinations and permutations, shared the duties of presenting the poster

session on "Carbon Monoxide/Ethanol Desulfurization of Coal" at the Fourth Annual Pittsburgh Coal Conference at Pittsburgh, PA, September 28-October 2, 1987; Illinois Corn Day, Springfield, IL, June 2, 1987; the First National Corn Utilization Conference, St. Louis, MO, June 11-12, 1987; the Fifth Annual National Conference on Alcohol Fuels at St. Louis, MO, July 28, 1987; Corn Daze, Minier, IL, August 2, 1987; Illinois State Fair, Springfield, IL, August 13-22, 1987; The Indiana Corn Growers Association, November 5, 1987, Terre Haute, IN; National Chemistry Day, Illinois State Water Survey, November 6, 1987, Champaign; the 10th Annual Illinois Soy-Corn Conference, November 23-24, 1987, Peoria, IL; the National Corn Grower's Association, February 24-26, 1988, St. Louis, MO; and the Illinois Corn Marketing Board Annual Contractors' Technical meetings on April 2, 1987, and March 30, 1988, Urbana, IL.

David L. Reinertsen, Jonathan H. Goodwin, George R. Carlisle, Jr. and other members of the ISGS staff led six field trips for school teachers and the general public during the reporting period. The trips were held in the Tunnel Hill area, April 16, 1987; the Dallas City area, May 16, 1987; the Park Ridge - North Shore area on October 3, 1987; the Pinckneyville area on November 7, 1987; the Shawneetown area on April 16, 1988; and the Canton area on May 21, 1988. A total of 470 people attended the four field trips in FY 1988.

J. Bruno Risatti presented the paper "Microbially enhanced separation of pyrite from Illinois coals, Part A: Mechanisms and enhancement of suppression" at the Illinois Coal Development Board Fifth Annual Contractors' Technical Meeting, July 28-30, 1987, Urbana, IL.

Michael L. Sargent represented the Illinois Geological Survey and participated in a field conference to study the Eau Claire-Mt. Simon boundary problem. The tour from Madison to Eau Claire, WI, July 28 - 30, 1987 involved representatives from the geological surveys of Illinois, Iowa, Minnesota and Wisconsin familiar with the stratigraphic problem in each of those states.

Paul R. Seaber presented a talk on "Hydrogeologic influences on the Florida phosphate industry's mining and waste disposal operations" at a meeting of the North-Central Section of the Association of Engineering Geologists, Chicago, IL, February 23, 1988.

Beverly J. Seyler presented the talk "Petroleum geology of western Illinois" for the Illinois Geological Society, September 29, 1987.

Lisa R. Smith presented the talk "Siting a low-level radioactive waste facility in Illinois: using the GIS to map exclusionary and favorability criteria" at the Midwest Regional ARC/INFO Users' Conference in Champaign, IL, October 14-16, 1987, and at the Illinois Mapping Advisory Committee meeting in Champaign, June 10, 1988. She also attended the ARC/INFO User Conference in Palm Springs, CA, March 21-25. 1988, where she participated in several training sessions during the week.

C. Brian Trask attended the annual meeting of the North-Central Section of the Geological Society of America, April 21-22, 1988 in Akron, OH, where he participated in a field trip to the Hardy Road Landfill and Industrial Excess Landfill - A Superfund Site.

Janis D. Treworgy attended the annual meeting of the American Association of Petroleum Geologists in Los Angeles, CA, June 7-10, 1987, where she participated in a field trip on the petroleum geology of coastal southern California. She also attended the annual meeting of the Eastern Section of AAPG in Columbus, OH, October 7-9, 1987, and the field conference on Middle Mississippian Rocks of southern Indiana held October 10, 1987, at Bloomington, IN, by the Great Lakes Section of the Society of Economic Paleontologists and Mineralogists.

John Valkenburg attended the annual Department of Energy and Natural Resources conference "Pesticides and Pest Management" in Chicago, November 12-13, 1987.

C. Pius Weibel attended the annual meeting of the North-Central Section of the Geological Society of America, Akron, OH, April 21-22, 1988 where he participated in a field trip on "Upper Pennsylvanian coals and associated rocks - depositional environments, sedimentation, paleontology and paleobotany."

Alan D. Williams attended the Second International Conference on Processing and Utilization of High Sulfur Coals at Carbondale, IL, September 28 - October 1, 1987.

Lectures/Classes/Seminars Taught

Richard C. Berg presented a lecture on sandy soil chronosequences for the Soil Geomorphology class at the University of Illinois, November 17, 1987, and a seminar on groundwater protection for the Geography Department of the University of Illinois, February 19, 1988.

Dwain J. Berggren presented the geology section of an earth science field trip at Kickapoo State Park near Danville for students from University High School of Urbana, May 6, 1988.

Chen-Lin Chou lectured on "Geochemistry of mineral matter and trace elements in Illinois Basin coal" at Beijing Graduate School of the China Institute of Mining in Beijing, China, September 13, 1987. He also presented a talk on "Geochemistry of Illinois Basin coal" at the Geology Department colloquium, University of Illinois at Urbana-Champaign, October 9, 1987.

Michael J. Chrzastowski led a one-day field trip along the Chicago lakefront for the University of Illinois Geography Department's coastal geomorphology class, September 20, 1987. **Dr. Leon Follmer** assisted Dr. Chrzastowski with the tour for the geography class. On March 25, 1988, Dr. Chrzastowski presented the lecture "On-going coastal geologic studies of Chicago's lakefront" to the Geology Department at Southern Illinois University, Carbondale, IL.

Dennis D. Coleman presented a lecture titled "The theory of radiocarbon dating" to the University of Illinois undergraduate honors course "Materials and civilization" during the class's tour of the Survey's radiocarbon dating laboratory, April 14, 1988. **Jack Liu, Keith Hackley, and Barry Fisher** discussed various aspects of the radiocarbon dating laboratory's operation for the class.

B. Brandon Curry presented a seminar on "Radiocarbon dating of older (>17,000 yrs. B.P.), organic-rich sediments and soils" for a class from the University of Illinois on May 11, 1988.

Joseph A. Devera presented a talk on exploring for dinosaur fossils and the life history of dinosaurs for the Carbondale School District in Carbondale, IL.

William G. Dixon, Jr. spoke to the Geography Club of Northeastern Illinois University on "Geology and hazardous waste" on September 29, 1987. On November 20, 1987, he addressed the Geology Colloquium of Northern Illinois University in DeKalb, IL, on "Engineering geology in northeastern Illinois."

Leon R. Follmer lectured to the SIU Geology Department about Quaternary studies in May, 1987, and to a geomorphology class at the University of Illinois on soil stratigraphy. He also discussed job opportunities in geology and reviewed the Canadian meeting of the International Union for Quaternary Research for the University of Illinois Agronomy Department.

Ardith K. Hansel presented the lecture "Evidence for a deforming bed during the advance of the Lake Michigan lobe in Illinois" to the Sedimentology Seminar and the lecture "Causes and timing of high lake phases of ancestral Lake Michigan to the Colloquium of the Geology Department, University of Illinois - Chicago in April 1987. She and **Richard C. Berg** led a field trip on lake level and sedimentation history at Indiana Dunes National Lakeshore, the Chicago lake outlet area, and Illinois Beach State Park for the Coastal Geomorphology class of the Geography Department, University of Illinois, October 16-18, 1987.

Richard D. Harvey presented a lecture on coal petrology for the geology department, Indiana University, Bloomington, IN, April 7, 1988.

Paul C. Helgold presented a field demonstration of seismic refraction techniques for the engineering geology class at the University of Illinois in May 1988.

Randall E. Hughes presented a lecture on "Clay mineral alteration associated with soils" for the clay mineralogy class in the Geology Department, and a seminar on "Clays in underclays and similar soil environments" for the Agronomy Department, University of Illinois at Urbana-Champaign.

Myrna M. Killey served as a resource geologist for a group of Phoenix, AZ, middle school earth science students on a field trip sponsored by the Geological Society of America Committee on Minorities in the Geosciences, October 28, 1987.

Dennis R. Kolata presented the lecture "Tectonic history of the Illinois Basin: an overview" for the Geology Department colloquium at the University of Illinois at Urbana-Champaign, April 15, 1988.

Robert J. Krumm presented the talk "ARC/INFO applications at the Illinois State Geological Survey" for the Earth Science Study Group of the University of Illinois at Urbana-Champaign, November 9, 1987.

E. Donald McKay III presented a lecture on computers and automated mapping for the class in remote sensing in the Geography Department, University of Illinois at Urbana-Champaign, August 1987.

Donald G. Mikulic presented the lecture "Silurian lagerstatten, the significance of soft-bodied Silurian fossils" for the Department of Geology, University of Iowa, Iowa City, October 16, 1987.

Duane M. Moore presented a seminar on the historical background of clay mineralogy for the Department of Agronomy, University of Illinois at Urbana-Champaign.

Russel A. Peppers presented a lecture on coal palynology for the coal geology class at Indiana University, Bloomington, IN, October 20, 1987.

J. Bruno Risatti presented a seminar for the Department of Civil Engineering, Northwestern University, Evanston, IL, May 4, 1987.

William R. Roy presented lectures on thermodynamic modeling of aqueous systems for the class in soil chemistry, Department of Agronomy, University of Illinois at Urbana-Champaign, May 2-6, 1988.

Christopher J. Stohr presented lessons on "Satellites, photographs and maps" for the 7th and 8th grade classes at University High School, Urbana, September 18, 1987, and for the 6th grade at Leal School, Urbana, April 24, 1987.

Stephen T. Whitaker presented a talk on geology as a career and the duties of a geologist to the 3rd Grade class at Robeson Elementary School, Champaign, IL.

Lawrence Wu presented a seminar on "Carbon monoxide/ethanol desulfurization of Illinois high-sulfur coal" for the Department of Agricultural Engineering, University of Illinois - Urbana-Champaign, April 18, 1988.

Offices/Committee Memberships in Scientific/Professional Societies

Terrie P. Adams of the Chicago Office is serving as a member of the Newsletter Committee of the Illinois Association of Environmental Professionals.

Margaret H. Bargh is secretary-treasurer of the Illinois Basin Section of the Computer Oriented Geological Society.

James W. Baxter is a member of the Mining Engineering Committee of the Society of Mining Engineers. He served as general chairman for the 23rd Forum on the Geology of Industrial Minerals and is currently serving as a member of the Steering Committee of the Forum on the Geology of Industrial Minerals, the committee that plans future meetings of this informal organization.

Robert A. Bauer is a member of the Rock Mechanics Committee of the Association of Engineering Geologists and is chairman of the Rock Mechanics Committee of the North Central Section of AEG.

Ross D. Brower serves as historian for the Midwest Groundwater Conference. He has also been a member of the Board of Directors of the Illinois Groundwater Association since October 1986. His term on the Board ends in October 1988.

Charles Collinson is a member of the sedimentological working group of the Society of Economic Paleontologists and Mineralogists.

Heinz Damberger is secretary-treasurer and program co-chairman for the Illinois Mining Institute. He also serves as chairman of the Rock Mechanics Award Committee of the Society of Mining Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME) and is a member of the Scholarship Committee of the Coal Division of the Geological Society of America.

William G. Dixon, Jr. was elected to the Board of the Illinois Association of Environmental Professionals for a one-year term beginning in January, 1988. He is also serving a one-year term on the By-Laws Committee of the North Central Section of the Association of Engineering Geologists and is the editor of the Section's newsletter.

Paul B. DuMontelle was elected chairman and a member of the Board of Directors of the North Central Section of the Association of Engineering Geologists for a two-year term beginning in October 1987. He is also a member of the Membership Screening Committee of the American Institute of Professional Geologists.

Henry P. Ehrlinger, III served as program chairman for the Industrial Minerals Division of the Society of Mining Engineers, organizing six program sessions totaling 30 papers during the 1987-1988 meetings. For 1988-89, Mr. Ehrlinger has been elected secretary-treasurer of the Division.

J. James Eidel is serving on the Membership Committee of the Society of Economic Geologists. He is also midcontinent representative for the SEG for the American Geological Institute's K-12 earth science education project.

Jonathan H. Goodwin is vice president of the Yellowstone-Bighorn Research Association.

Ardith K. Hansel was elected to a 4-year term as councilor for the Historical Geology and Stratigraphy Seat of the American Quaternary Association at its biennial meeting in Amherst, MA, June 5, 1988. She also serves as a corresponding committee member of the Subglacial Processes and Sediments Work Group, Commission on Formation and Properties of Glacial Deposits, International Quaternary Association.

Richard D. Harvey has served since 1985 as chairman of the Subcommittee on Classification of Coal of Committee D-5, Coal and Coke, of the American Society for Testing and Materials and as vice president of the Society for Organic Petrology from October 1987 to October 1988.

Bruce R. Hensel completed his term of office as co-editor of the Illinois Groundwater Association newsletter in December 1987. He was succeeded in that office by **Beverly L. Herzog**.

Beverly L. Herzog is a member of the Association of Ground Water Scientists and Engineers and has served as a member of the editorial board of the Association's journal *Ground Water* since 1985. In February of 1988, Ms. Herzog was named a member of Committee D-18, Soil and Rock, of the American Society for Testing and Materials.

Richard H. Howard is a member of the Geological Committee of the Illinois Oil and Gas Association, the Enhanced Recovery Committee of the Interstate Oil Compact Commission, and the Potential Gas Committee.

Randall E. Hughes served on the Publications Committee of the Clay Minerals Society from 1984 to 1987, currently chairs the Publicity Committee of the Society, and was elected to the Council of the Society at the annual meeting in Socorro, NM, October 1987. He and **James C. Bradbury** [emeritus] are co-editing the Proceedings of the 23rd Forum on the Geology of Industrial Minerals. Since 1984, Dr. Hughes has served on the Mining Engineering Committee of the Society of Mining Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers.

Russell J. Jacobson is serving as president of the Illinois Basin Section of the Computer Oriented Geological Society until the fall of 1988. He is also serving as newsletter editor for the Illinois-Indiana Section of the American Institute of Professional Geologists.

Latif A. Khan is a member of the Technical Papers Subcommittee of the Society of Mining Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers.

Myrna M. Killey is president-elect and chair of the Membership and the Regulatory and Legislative Committees of the Illinois-Indiana Section of the American Institute of Professional Geologists for the year 1988. She has served as AIPG Liaison to the North Central Section of the Association of Engineering Geologists since 1986.

Morris W. Leighton is statistician for the Association of American State Geologists and a member of the Liaison Committee for that organization. From 1986-1988 he chaired the Ad Hoc Committee on Geographic Information Systems for the AASG.

John M. Masters is a member of the Educational Issues Committee of the Society of Mining Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers.

Duane M. Moore is a member of the publicity committee of the Clay Minerals Society.

Donald F. Oltz was recently elected chairman of the Research Grant Award Committee of the Illinois Geological Society. He is continuing to serve on the Research Committee, the Committee on the Statistics of Drilling, and as the State of Illinois representative on the Membership Committee of the American Association of Petroleum Geologists.

Russel A. Peppers is a member of the Pennsylvanian Working Group of the Society of Economic Paleontologists and Mineralogists and a member of the Working Groups on Subdivision of the Pennsylvanian and the Middle Pennsylvanian of the Subcommission on Carboniferous Stratigraphy, International Union of Geological Sciences.

Vickie R. Poole has been co-editor of the Illinois Groundwater Association Newsletter since October 1987.

J.Bruno Risatti is a member of the Committees on Microbial Mat Communities, and Biochemical Evolution for the Precambrian Paleobiology Research Group of the Center for the Evolution and Origin of Life, University of California at Los Angeles.

Rodney R. Ruch is secretary of Subcommittee 5, Methods of Analysis, of Committee TC27 of the International Standards Organization. He is also a member of Committee D-5 on "Coal and Coke" of the American Society for Testing and Materials, and attended the Committee's meetings in St. Louis, MO, in October 1987 and Williamsburg, VA, in May 1988.

Irma E. Samson assists in organizing the annual meetings of the Illinois Mining Institute.

Paul R. Seaber is co-chairman of the Hydrostratigraphic Units Committee of the Hydrogeology Division, Geological Society of America. He is also co-chairman of the Hydrogeology Division's Program Committee for the 1989 annual meeting to be held in St. Louis. Dr. Seaber is an editor of the volume on "Hydrogeology of North America" for the Geological Society of America's Decade of North American Geology series.

Christopher J. Stohr is chair of the Engineering Applications Committee of the Remote Sensing Applications Division, American Society for Photogrammetry and Remote Sensing, for 1987-1988. He is also serving as director of the Great Lakes Region for ASPARS for 1986-1989 and was a co-organizer of the GIS session at the fall meeting of ASPARS for 1987 held in Urbana. Mr. Stohr also serves as editor of the newsletter for the North-Central Section of the Association of Engineering Geologists.

C. Brian Trask has been a member of the Working Group on Modern Methods of Grain Size Analysis of the International Union of Geological Sciences since 1984. He is also a member of the Midcontinent Pennsylvanian Stratigraphic Working Group.

Stephen T. Whitaker is an official delegate from Illinois to the American Association of Petroleum Geologists.

Offices/Committee Memberships in Educational/Professional Societies

Donald R. Dickerson is serving as co-chairman of the Science Talent Search Committee of the Illinois State Academy of Science from April 1987 to October 1988 and in that capacity made presentations to the Westinghouse Science Talent Search winners at the Annual Banquets of the Illinois Junior Academy of Science in Champaign in May 1987 and 1988. He serves as the Illinois State Academy of Science's representative on the Junior Academy Board and is the Junior Academy's representative on the State Academy's Council. He is campus coordinator for the Paper Sessions of the Illinois Junior Academy of Science State Science Fair held at Champaign each May and also assists in judging Fair projects.

Henry P. Ehrlinger, III is an evaluator appointee for the Accreditation Board for Engineering and Technology, Inccorporated. In connection with this appointment, he attended a one-day indoctrination seminar in January 1988.

Lynn D. Evans is a member of the banquet committee of the Tau Beta Pi engineering student honorary society, treasurer of the Chi Epsilon civil engineering student honorary society, a member of Phi Kappa Phi campus-wide student honorary society, and a member of the Engineering Open House and Class Note Sales committees of the Student Chapter of the American Society of Civil Engineers.

John M. Masters is judging chairman for the Earth Science Division at the annual Junior Academy of Sciences State Science Fair. **Philip C. Reed** assists him as co-chairman and **William Dey, Donald R. Dickerson, Jonathan H. Goodwin, Randall E. Hughes, Russell J. Jacobson, Myrna M. Killey, Edward C. Smith, Wen-June Su, and Stephen T. Whitaker** have served as judges at the fairs during the last two years. **John D. Yeko** was a judge in the Computer Science division at the Science Fair in May 1988.

CONTRIBUTIONS TO OTHER GOVERNMENT AGENCIES

Testimony/Informational Presentations to Local/State/National Committees

Robert A. Bauer presented testimony at Belleville, IL, November 7, 1987, to the Subsidence Task Force, Illinois House of Representatives Standing Committee on Urban Redevelopment, about ISGS involvement in mine subsidence research and the results of past ISGS studies of the efficacy of backfilling methods employed in the East St. Louis area in an attempt to control mine subsidence.

Michael J. Chrzastowski and Charles Collinson met with representatives of the Division of Water Resources of the Illinois Department of Transportation, the Chicago Park District, the U.S. Army Corps of Engineers, Chicago District, and the U.S. Geological Survey in Chicago, June 24-26, 1987, to develop a coordinated plan for Lake Michigan research.

Charles Collinson provided information or made presentations for several meetings sponsored by the Division of Water Resources of the Illinois Department of Transportation. The meetings included: April 16-17, 1987, local agencies conference on littoral drift budgets and shore structure design elevations; June 24, 1987, local agencies conference on shore studies planning; August 5, 1987, local agencies emergency conference on littoral drift impoundment and construction permitting. He also presented a slide-illustrated talk on "Illinois' Lake Michigan shore needs" to Congressman Harrison Fawell's Science Advisory Committee in Naperville, April 25, 1987. At the Annual Project Review Conference of the Illinois-Indiana Sea Grant program, October 23, 1987, he provided critical review testimony.

Paul B. DuMontelle and Michael V. Miller presented information at a hearing before the board of the Hastings Drainage District in Danville, IL, April 13, 1988, regarding erosion and deposition problems in the Hastings Branch of Goodall Creek. They also presented information on the subject at a meeting in Homer on May 16, 1988. At the meeting of the ISGS Coal Advisory Committee on May 11, 1988, Mr. DuMontelle reviewed the status of the Illinois Mine Subsidence Research Program.

David L. Gross briefed the State Government Administration Committee of the Illinois House of Representatives on the scope of the SSC project. He also provided information on the progress of the SSC project for the Illinois Congressional delegation several times and met with the Board of SSC for Fermilab, Incorporated, in Chicago to provide progress reports on five occasions.

Beverly L. Herzog presented a seminar for the McLean County Board in June 1987 on "Hydrogeologic aspects of landfill siting" for the McLean County Board to prepare them for upcoming hearings on a proposed landfill. At those hearings, Ms. Herzog served as a technical adviser to the Board and supplied the Board members with questions on hydrogeology to address to the landfill permit applicant.

Morris W. Leighton and Donald F. Oltz discussed the state of the domestic oil industry, Illinois' position within the oil industry, the prospects for increased domestic production through improved and/or enhanced recovery of in-place, unswept mobile oil, and the Illinois State Geological Survey's role in encouraging increased production in Illinois at a breakfast meeting for selected state and federal legislators and their staffs in Mt. Vernon, IL, April 11, 1988.

Michael V. Miller attends the quarterly meetings of the state Water Plan Task Force of the Division of Water Resources, Illinois Department of Transportation, and the Wetlands Advisory Committee of the Illinois Department of Conservation. In August 1987 he attended the annual watershed priority meeting of the Illinois Department of Agriculture.

David M. Rapp discussed the status of the ISGS aggregate flotation project for the Coal Advisory Committee of the ISGS, May 11, 1988.

J. Bruno Risatti presented information as an expert witness at an interagency meeting of the U.S. EPA, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers and Illinois EPA regarding the dredging of Waukegan Harbor, June 12, 1987. He also discussed research plans at an interagency staff meeting to develop a plan of study for the Indiana Harbor environmental investigations. The meeting included representatives of the U.S. Army Corps of Engineers, U.S. EPA Region 5 Office, U.S. Fish and Wildlife Service, Indiana Department of Natural Resources, Indiana Department of Environmental Management, and Indiana University - Northwest.

Paul R. Seaber and other staff members of the Groundwater Section met with Senator Jerome Joyce and members of the Senate staff to discuss the provisions of the Water Use Act of 1983 and the problems of the influence of irrigation wells on water supply problems in Pembroke Township, Kankakee County.

Christopher J. Stohr discussed Side-Looking Airborne Radar imagery for the Illinois Mapping Advisory Committee meeting at Champaign, March 11, 1988. He also prepared a videotape comparison of two types of thermal Infrared detector instruments for the Indiana State Police.

Lawrence Wu discussed the current status and future prospects of the carbon monoxide/ethanol desulfurization of high sulfur coal for the Illinois State Geological Survey's Coal Advisory Board at its annual meeting, May 11, 1988. At the same meeting, **Colin G. Treworgy** discussed "Participation of the ISGS in a national study of the availability of coal resources for development" and **Alan D. Williams** discussed the status of the project on "Production of premium liquids by mild gasification."

Testimony/Informational Presentations at Civil/Criminal Court Proceedings

Donald R. Dickerson served as an expert witness at a retrial of a murder case in Clark County, April 4, 1988, where he presented evidence from chemical analyses of wood samples collected from a tree at the scene of the crime. According to a letter from the Attorney General of the State of Illinois, Dr. Dickerson's testimony was instrumental in convicting the murderer a second time. The case was remanded back to the lower court on appeal following an earlier decision to convict.

Membership/Participation in Local/State/National Government Advisory Committees

James W. Baxter and J. James Eidel represented the ISGS as an intervenor in a series of mediation sessions to negotiate consensus positions and agreements that led to settlement of various appeals to the U.S. Forest Service's 10-year management plan for the Shawnee National Forest in southern Illinois. Baxter and Eidel presented data on known mineral resources in the region, discussed the emerging evidence for possible deep-seated, rift-related mineralization in the region, and advocated maintaining access in the region for environmentally responsible mineral resource exploration.

Richard C. Berg attended meetings of the Interagency Coordinating Committee on Groundwater, an intergovernmental committee organized under provisions of the new Illinois Groundwater Protection Act, on September 21 and December 1, 1987, and February 2, 1988, in Springfield. He is also a member of the Illinois Department of Nuclear Safety's Technical Advisory Committee

for Low-Level Radioactive Waste Disposal Siting, and attended meetings of the committee in Springfield on April 27 and June 10, 1988.

Dwain J. Berggren participated in the New Horizons workshop held by the Champaign County Forest Preserve District to identify critical issues and recommend long-term actions for management of the District's lands and programs, October 24, 1987.

Ross D. Brower is a member of the Underground Injection Control technical advisory group of the Illinois Environmental Protection Agency's Division of Land Pollution Control.

Charles Collinson was named a member of the Chicago Shoreline Protection Commission by the late Mayor Harold Washington and continues to serve in that capacity. The Commission met on alternate Wednesdays from February through November 1987. He was named Chairman of the Structural Measures Working Group of the Commission which met semi-monthly from May 1987 through March 1988, when its final report was issued; he also served on the Executive Committee of the Working Group. The Executive Committee prepared detailed semi-monthly progress reports for review by the Commission. Dr. Collinson is also serving on the Scientific Advisory and Review Committee of the Illinois-Indiana Sea Grant Program for 1987-88.

William G. Dixon, Jr. is a member of the Radiological Assessment Field Team for the Illinois Department of Nuclear Safety.

Paul B. Dumontelle is vice chair of the Illinois Mapping Advisory Committee in his capacity as topographic mapping coordinator for the ISGS. He is also president of the Boneyard Creek Commission of Champaign County and conducts monthly meetings.

J. James Eidel is a member of the Wetlands Advisory Committee of the Illinois Department of Conservation and attends quarterly meetings of the Committee in Springfield.

Jonathan H. Goodwin and David L. Reinertsen represent the ISGS on the Education Subcommittee of the Interagency Coordinating Committee on Groundwater chaired by Mitch Beaver of the Department of Energy and Natural Resources. The subcommittee meets about six times a year to plan and coordinate educational activities on groundwater protection.

David L. Gross and E. Donald McKay III are State of Illinois representatives to the Computerized River Information Center Advisory Team of the U.S. Fish and Wildlife Service. The work is supported by the USFWS with funds from the U.S. Army Corps of Engineers.

Richard D. Harvey is on the Advisory Committee for the Illinois Basin Coal Sample Program.

Russell J. Jacobson has served as chairman of the Tri-State Committee on Correlation of the Pennsylvanian System in the Illinois Basin. **C. Brian Trask** is a member of the Committee.

Latif A. Khan is a member of an advisory panel on Research Needs and Opportunities in Chemical Engineering for the National Research Council.

Morris W. Leighton is a member of the Committee Advisory to the U.S. Geological Survey and served as a member of the Ad Hoc Hydrocarbon Drilling Committee, both committees sponsored by the National Academy of Sciences/National Research Council. He also serves as Secretary to the Coal Advisory Committee of the Illinois State Geological Survey and as a member of the Research Committee of the Interstate Oil Compact Commission.

E. Donald McKay III represents the State Geological Survey on the Prime Policy Committee, the interagency committee that oversees the operation of the Prime computer system and the Geographic Information System.

Donald F. Oltz is a member of the Energy Resources Committee of the Interstate Oil Compact Commission.

David L. Reinertsen represents the Director of the Department of Energy and Natural Resources on the Conservation Education Advisory Board of the Illinois Department of Education at bi-monthly meetings in Springfield.

Rodney R. Ruch is a member of the Program Advisory Committee of the Center for Research on Sulfur in Coal and, as a member of that committee, reviews the CRSC's Program Assessment Report and Program Implementation Plan.

Paul R. Seaber, as head of the Groundwater Section, represents the Geological Survey on the Advisory Committee of the Hazardous Waste Research and Information Center. He is also a member of the groundwater quality subcommittee of the State Water Plan Task Force, Division of Water Resources, Illinois Department of Transportation. For the U.S. Geological Survey, he serves on the advisory committee of the Upper Illinois River Basin project of the National Water Quality Assessment (NAWQA) program.

C. Brian Trask is a chairman of the Environmental Advisory Commission of the Champaign City Council, which meets monthly.

CONTRIBUTIONS TO THE PUBLIC AND INDUSTRY

Popularized Addresses/Presentations for Civic Groups/Public Meetings

Robert A. Bauer presented a talk on the geological and geotechnical studies for siting the SSC in Illinois at meetings of the Midwest Physicists at the University of Chicago, and at the Champaign-Urbana Breakfast Rotary Club.

Richard C. Berg presented a talk on groundwater protection to the Staley Technical Society at Decatur, March 10, 1988, and to the Illinois Association of Soil and Water Conservation Districts, December 14, 1987. He discussed the ISGS research and service program for geology-for-planning studies with the executive director of the Society for the Illinois Scientific Surveys and her assistant, who visited the Surveys in Champaign November 30, 1987.

Michael J. Chrzastowski presented a slide-illustrated talk about the on-going Chicago lakefront coastal studies for the monthly luncheon meeting of the Illinois Association of Environmental Professionals in Chicago, September 24, 1987. At the November 13, 1987, meeting of the Illinois Section of the American Society of Civil Engineers in Chicago, he presented a slide-illustrated talk on the results of the side-scan sonar studies of Lake Michigan shore defense structures.

Charles Collinson presented the slide-illustrated talk "Rising lake levels: impacts and alternatives" and participated in a panel discussion at the annual convention of the National Association of Environmental Professionals held at the Ambassador West Hotel in Chicago, April 29, 1987. For Bright New City, a civic association in Chicago, Dr. Collinson presented a lecture on the "State of the Chicago Shore" and participated in a panel discussion with Chicago Public Works Commissioner Paul Karas and architect Dirk Lohan at the Casino, April 6, 1987. On April 9, 1987, Dr. Collinson delivered a public lecture on the Chicago shorefront at the Chicago Academy of Sciences. For the evening lecture series of the Field Museum of Natural History, he presented the lecture "A history of lake levels" on May 5, and "Crisis on the lakefront" on June 2, 1987. At the annual meeting of the Association of American State Geologists in Traverse City, MI, June 8, 1987, Dr. Collinson presented a slide-illustrated lecture on the Survey's Lake Michigan research program. On October 16, 1987, he presented the slide-illustrated lecture "The Chicago shoreline emergency" for the Great Lakes Interleague of Women Voters meeting at Lansing and he presented a slide-illustrated lecture on the Lake Michigan shoreline for the Urbana Exchange Club on March 16, 1988. Drs. Collinson and **Michael Chrzastowski** have met with members of the

local and/or national press or held telephone interviews with newspaper and radio reporters on more than 30 occasions during the past two years.

B. Brandon Curry addressed the Bloomington Illinois Rotary Club on February 4, 1988 on "The SSC in Illinois." He, **Bob Bauer, Lucille Curran, Anne Graese, David Gross, Carol Hindman, Jennifer Hines, John Kempton, and Bob Valden** together and individually, represented the Geological Survey at many other public meetings about the SSC, presenting the results of the geotechnical and environmental studies with an extensive collection of posters and slides at such meetings as the SSC Leadership Committee meeting in Chicago, November 19, 1987; LaGrange, January 22, 1988; public meetings in Kane County February 1, 2, and 3, 1988; the SSC Open House at Batavia, February 13, 1988; the Environmental Impact Statement scoping meeting at Batavia on February 18, 1988; public presentations on February 22 and April 9, 1988, at Oswego; April 30, 1988, at Aurora; and June 21, 1988, at Springfield.

Paul B. DuMontelle and Michael V. Miller presented information on the problems of erosion and deposition in the Hastings Branch of Goodall Creek at a public meeting in Homer, May 11, 1988.

J. James Eidel presented a talk on the natural history of New Zealand to the Vermilion County Audubon Society on February 25, the Izaak Walton League of Champaign on March 10, and the Champaign County Audubon Society on April 1. On June 8 he discussed "The future of Illinois mineral resources and you" at the Urbana Exchange Club.

David L. Gross presented more than 45 public addresses, primarily directed toward siting the SSC in Illinois, for groups ranging from the Beardstown Public Library to the Illinois Congressional delegation to the editorial boards of downtown and Chicago suburban newspapers.

Ardith K. Hansel presented a slide-illustrated talk on "Glaciers and what they do" at the Methodist Women's Regional Breakfast in northeastern Iowa in July, 1987. In September, 1987, she spoke to the Lake County Dunesland Preservation Society on "Lake Michigan high lake levels, past and future."

Robert J. Krumm presented the talk "Geologic applications of ARC/INFO: current developments and projects at the Illinois State Geological Survey" for the staff of the Urbana, Illinois office of the Water Resources Division, U.S. Geological Survey, December 18, 1987.

Dennis P. McKenna presented a talk on "Pesticides in Illinois groundwater" at the annual meeting of the Illinois Environmental Council in Springfield, IL, October 24, 1987. For the Society for the Illinois Scientific Surveys meeting in Peoria, IL, September 22, 1987, Mr. McKenna lectured on "Agricultural chemicals in shallow groundwater in Mason County." At a meeting on water quality in Robinson, IL, March 28, 1988, sponsored by the Crawford County Soil and Water Conservation District, the University of Illinois Cooperative Extension Service, and the Illinois Department of Public Health, Mr. McKenna presented a talk on "Agricultural chemicals in groundwater." At the same meeting in Robinson, **Edward C. Smith** presented the talk "Is your water safe? - A water quality program for Crawford County".

Donald G. Mikulic presented an illustrated talk on soft-bodied Silurian fossils and their importance in the history of life for the Mid-America Paleontological Society meeting in Macomb, IL, April 25, 1987.

David L. Reinertsen presented the slide-illustrated lecture "The Ice Age in Illinois" for a group at the Illinois State Museum, January 16, 1987.

Michael L. Sargent presented talks on the Illinois Basin Ultradeep Drillhole project to the Lincoln Orbit Earth Science Society in Rochester, IL, December 20, 1987, and to the Mahomet Lions Club on February 8, 1988.

C. Pius Weibel was a panel speaker at a life forum for Channing-Murray Foundation, Urbana, IL, March 3, 1988, where he discussed "Science for science's sake: academic research as a career alternative to corporate science."

Membership/Service in Local/State/National Civic/Charitable Organizations

Dwain J. Berggren served during 1987-88 as Vice President of GROW, Incorporated, of Illinois, a not-for-profit community mental health organization.

Subhash B. Bhagwat participates in the annual fund-raising drive of the American Heart Association.

Donald R. Dickerson chairs the Athletic Committee of the Kiwanis Club of Champaign-Urbana which sponsored the University of Illinois varsity Basketball banquet, April 11, 1988.

Gary B. Dreher has served as unit leader for the Campus Charitable Fund Drive and the Campus United Health Appeal at the Geological Survey for the last two years. For the 1988 drive he is being assisted by **Suzanne Muckensturm, K. Kay Knee, Joanne Klitzing, Elwood Atherton and Debra Sands**. In 1987, **Kristi Brewer, Suzanne Muckensturm, Elwood Atherton, and Kathy Cooley** assisted Dr. Dreher.

J. James Eldel is President of the Champaign County chapter of the National Audubon Society. He initiated the S. Charles Kendeigh Memorial Fund, which is providing scholarship assistance to three University of Illinois graduate students in ornithology who are studying Illinois-related problems.

George Carlisle, Jr., Heinz Damberger, Paul DuMontelle, Edward Gefell, Jonathan H. Goodwin, Beverly L. Herzog, Robert J. Krumm, Alison Lecouris, Kristi A. Mercer, Mary E. Peters, Lisa R. Smith, and Gail D. Taylor have assisted at fund-raising drives for WILL-TV in Urbana.

David L. Gross served as a facilitator for the Champaign County United Way retreat in January 1988. He is a member of the Board of Directors, and a member of the Marketing and Second Century Committees of United Way of Champaign County. He is also a member of the Advisory Committee of the Campus Charitable Fund Drive. He has served the Urbana Rotary Club as past president (1987-88) and as a member of the Board (1985-88).

Beverly L. Herzog is a member of the Board of the DeWitt County Chapter of the American Red Cross and chair of the Committee on Volunteer Recognition. She is also a certified instructor of cardio-pulmonary resuscitation and first aid.

Morris W. Leighton is a member of the Board and coordinator for International Projects for 1987-88 for the Urbana Rotary Club. He also serves as vice president of the Friends of the University of Illinois Library for 1987-88 and chairman of that organizations's Development Committee. During the past year, The Friends organization was instrumental in raising funds needed to restore and preserve the Library's copy of the Audubon "elephant portfolio" *Birds of America.*

Russel A. Peppers serves as a leader and resource adviser in general science for the Helping Hands Club of the Champaign County 4-H.

Michael L. Sargent is active in the Mahomet Lions Club. He served as co-chairman of the Mahomet Lions Club Candy Day, held October 2, 1987, to raise money for the Lions of Illinois Eye Research Center. He is also a member of the Club's Constitution and By-laws Committee. He serves as a member of the Buildings and Grounds Committee of the Urbana Sportsman's

Club, is vice-president of the Champaign-Urbana Coin Club, and is a member of the Champaign-Urbana Stamp Club.

Robert C. Valden has served on the board of the Champaign County Audubon Society since 1986, and is active in prairie preservation/restoration projects.

Other Public Services

Terrie P. Adams served as a judge for a Science Fair at Near North Career High School in Chicago, and **Robert J. Krumm** was a judge at a Science Fair at Jefferson Middle School in Champaign, February 9, 1988.

Russell J. Jacobson led two public fossil-collecting field trips for the Urbana Park District to southern Illinois, October 24-25, 1987, and to southern Indiana and north-central Kentucky, March 1988.

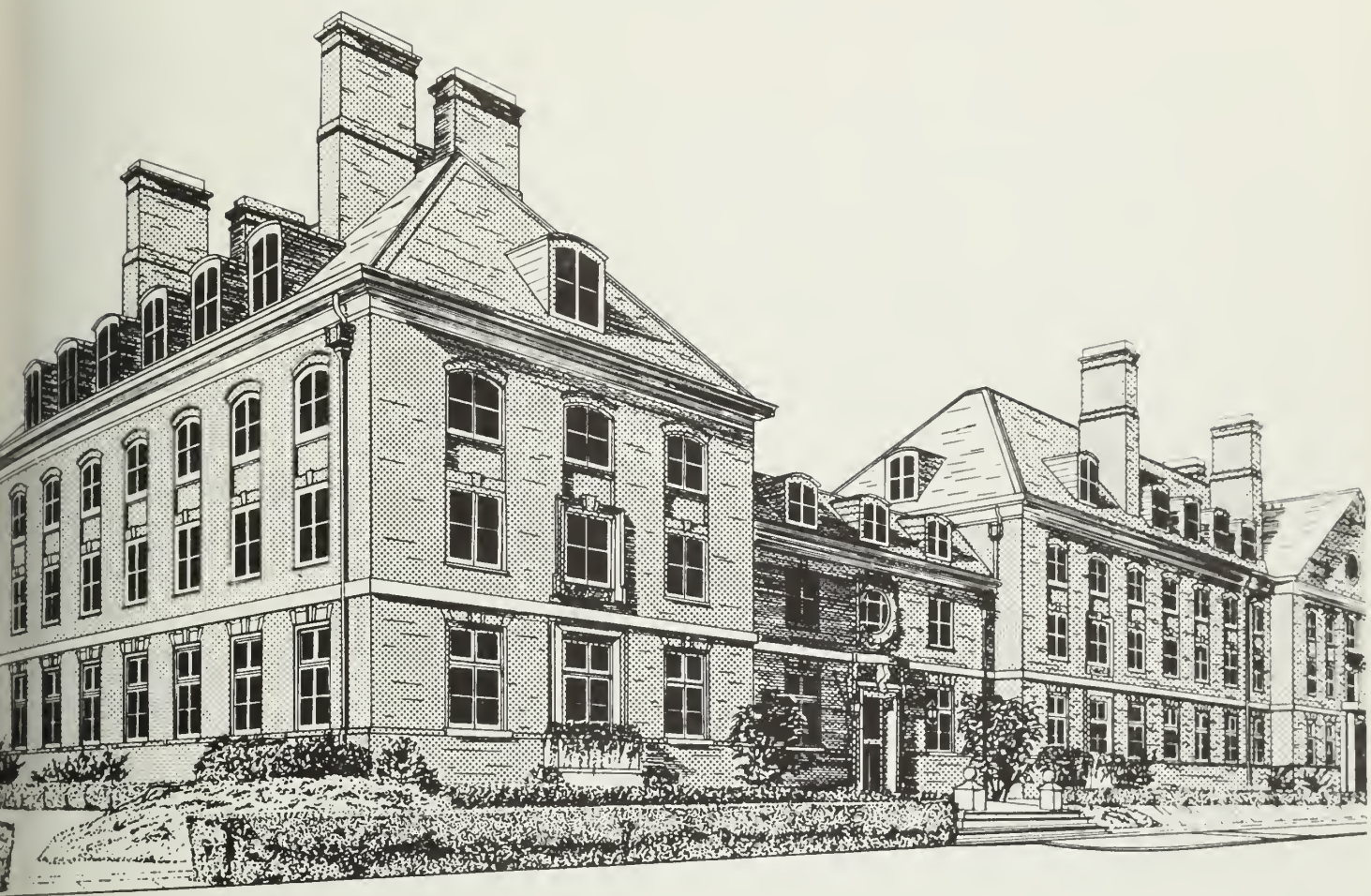
Alison Lecouris served as a computer programming judge for the Junior Achievement Science Fair at Champaign in April 1988.

Paul R. Seaber is a soccer coach for the Champaign Park District.

Graduate Degrees Awarded

Ivan G. Krapac was awarded the degree of Master of Science in Soil Chemistry by the Department of Agronomy, University of Illinois at Urbana-Champaign in December 1987.

C. Plus Welbel was awarded the degree of Doctor of Philosophy in Geology by the Department of Geology, University of Illinois at Urbana-Champaign on May 22, 1988.



LINOIS STATE GEOLOGICAL SURVEY ANNUAL REPORT

ay 1987–June 1988

UBLICATIONS

ILLINOIS STATE GEOLOGICAL SURVEY

Publications

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ISGS SERIES

(Released to the General Public between March 16, 1987, and June 30, 1988)

Circulars

538 Structural geology of southeastern Illinois and vicinity. 1987. **W.J. Nelson and D.K. Lumm**, 70 p., 2 plates.

539 Stratigraphic correlations of the Seelyville, Dekoven, and Davis Coals of Illinois, Indiana, and western Kentucky. 1987. **R.J. Jacobson**, 27 p., 12 figures, 7 tables, 2 plates.

540 The Hornsby District of low-sulfur Herrin Coal in central Illinois (Christian, Macoupin, Montgomery, and Sangamon Counties). 1987. **W.J. Nelson, with contributions by P.J. DeMaris and R.A. Bauer**, 40 p., 28 figures, 1 plate.

543 Regional geology of the Tiskilwa Till Member, Wedron Formation, northeastern Illinois. 1988. **S.S. Wickham, W.H. Johnson, and H.D. Glass**, 35 p., 21 figures, 4 tables.

Environmental Geology Notes

117 Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois: results of the fall 1984 test drilling program. 1987. **J.P. Kempton, R.A. Bauer, B.B Curry, W.G. Dixon, Jr., A.M. Graese, P.C. Reed, M.L. Sargent, and R.C. Vaiden**, 102 p., 54 figures, 25 tables.

118 Characteristics and potential uses of waste from the historic longwall mining district in north-central Illinois. 1987. **S.C. Bradford, D.J. Berggren, and P.B. DuMontelle**, 50 p., 22 figures, 4 appendixes.

119 Hydrogeologic evaluation of the effects of surface application of sewage sludge to agricultural land near Rockton, Illinois. **R.C. Berg, W.J. Morse, and T.M. Johnson**, 42 p., 14 figures, 5 tables.

120 Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois: results of the spring 1985 test drilling program. 1987. **J.P. Kempton, R.A. Bauer, B.B. Curry, W.G. Dixon, Jr., A.M. Graese, P.C. Reed, and R.C. Vaiden**, 88 p., 45 figures, 25 tables.

121 Inventory of Lake Michigan research projects, 1984-1987. 1987. **N.P. Holm**, 424 p.

122 Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois: results of the 1986 test drilling program. 1988. **B.B. Curry, A.M. Graese, M.J. Hasek, R.C. Vaiden, R.A. Bauer, D.A. Schumacher, K.A. Norton, and W.G. Dixon, Jr.**, 108 p., 58 figures, 37 tables.

124 Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois: results of drilling large-diameter test holes in 1986. 1988. **R.C. Vaiden, M.J. Hasek, C.R. Gendron, B.B. Curry, A.M. Graese, and R.A. Bauer**, 58 p., 17 figures, 11 tables.

126 Potential impact of material to be excavated from the Illinois SSC tunnel on surface water and groundwater resources. 1988. **I.G. Krapac, W.R. Roy, R.A. Griffin, and T. Beissel**, 19 p., 2 figures, 5 tables.

127 Natural background radiation in the proposed Illinois SSC siting area. 1988. **R.H. Gilkeson, R.A. Cahill, and C.R. Gendron**, 47 p., 22 figures, 9 tables.

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